Appendix B
Reference Drawings and Data

B-1. General

System drawings (Figures B-1 through B-22) and specification excerpts presented next in paragraphs B-2, B-3, and B-4 are essentially systems and equipment used in various existing powerhouses, but both have been modified in certain respects to make them more generally applicable. However, their use for new powerhouse design will seldom be practical due to the differing requirements characteristic of each new project. They are included to acquaint the designer with satisfactory designs typical of one or two sizes and types of powerhouse. Certain line sizes and elevations have been retained on the drawings as an aid in visualizing the particular system layout but should be regarded as relative only. Where a figure includes two, three, or more separate drawings, appreciable differences in powerhouse requirements and system provisions will be noted. These figures and specifications are referenced in the manual write-ups and as otherwise needed during design.

B-2. Piping-Cleaning and Flushing

a. General. Prior to installation, piping, fittings, and valves shall be cleaned as required to remove all foreign matter. During installation, openings in the piping shall be covered to prevent entry of foreign material. Concrete, curing water, or construction debris shall not be washed into drains. Piping shall be kept clean, and the contractor shall demonstrate that the pipes and drains are unobstructed when so directed by the Contracting Officer. Any stoppage or other damage to materials, equipment, or parts of the building due to the contractor's failure to properly clean the piping systems shall be repaired by the contractor without cost to the government. The contractor shall provide all materials and equipment required to clean and flush the piping systems including temporary piping, solvent, and circulating pump except as otherwise noted. After installation and prior to connection to equipment, each system shall be thoroughly flushed until clean. Unless otherwise noted, the flushing and cleaning fluid shall be the same as medium specified for the pressure test. Temporary cross connections shall be installed between supply and return lines at each branch extremity, and each branch shall be cleaned and flushed in a separate operation. The supply and return lines in the oil room shall be isolated from the tanks and pumps until testing and flushing operations have been completed. Oil used for flushing shall not be drained to the dirty oil tank but shall be collected for disposal by the contractor. All such oil shall be drained from the low points in the lines.

b. Cleaning oil system. Special care shall be taken to ensure that materials used in the oil system are clean and that shavings, solder, or other foreign materials do not enter the system. The contractor shall obtain approval for his cleaning and flushing procedures by the Contracting Officer prior to starting cleaning operations. An organic solvent which will remove the flux residue and also will be soluble in the subsequent hot oil flush shall be passed through the piping until the flux residue is removed. Prior to this solvent cleaning operation, the contractor shall demonstrate by the use of test sections of soldered copper tubing and fittings that the solvent cleaning operation will effectively clean out the flux residue left in the soldering process. Lines shall be drained of solvent and shall be blown out prior to being pressure tested.

c. Flushing oil system. After the piping has been solvent cleaned and pressure tested, but before the oil lines are connected to the generators, turbines, governor equipment, and oil storage tanks and pumps, oil shall be circulated through the supply and return lines at a minimum velocity of 4.6 m/s (15 f/s) for 8 hr or until they are clean. An 80- by 80-mesh screen or comparable filter shall be installed at the end of the return oil line. Clean warmed oil shall be circulated through all circuits of the piping until the screen remains clean. The oil temperature shall be between 60-66°C (140-150°F). The oil used for the pressure testing shall be used for flushing. The oil shall be recirculated so that the quantity required will not be excessive. The contractor may use the oil purifier to heat the oil. The purifiers and government-furnished oils will be made available to the contractor at the locations needed. Oil circulating pumps used in conjunction with the oil purifier shall be matched to the volume flow rate of the purifier and shall be equipped with a bypass. A detailed drawing of the proposed circulating pumps-oil purifier joint operation shall be submitted for approval. If an extension power cord for the oil purifier is needed, it shall be provided by the contractor. The purifier shall be cleaned and serviced after use.

B-3. Powerhouse Piping

a. Pressure tests.

(1) General. The contractor shall furnish all equipment and materials required to make complete tests, except as otherwise specified. The tests shall be made with blank flanges or with suitable caps on ends of the

pipe sections to be tested. The pipings tests shall be conducted before the equipment has been connected to the piping. All sections of the piping specified herein shall be tested by the contractor and approved by the Contracting Officer before acceptance. Any defects or leaks disclosed by tests shall be satisfactorily repaired and retested by the contractor at no additional cost to the Government. The contractor shall notify the Contracting Officer in sufficient time before starting any test to permit a representative of the Contracting Officer to witness the test. Each welded joint shall be hammered while under test pressure. All piping shall be tested at the pressure shown in Table B-1 for a length of time sufficient in the opinion of the Contracting Officer to determine tightness but in no case less than one hour except as noted. Air lines tested with water shall be thoroughly dried after testing and before connecting to equipment.

(2) Test pressure and mediums. The test pressures and mediums are shown in Table B-1 for the following categories of piping:

b. Carbon dioxide piping. The carbon dioxide piping, including that portion in the generator housing, shall be pressure tested as follows. All piping including the flexible tubing shall be subjected to a gas pressure test of 6,894 kPa (1,000 psi). Only nontoxic and nonflammable gases shall be used to test. The gas pressure shall not fall below 6,205 kPa (900 psi) at the end of a test period of 5 min. All personnel shall be removed to positions of safety while the systems are under test pressures, with the pressure gauge used for testing being the only pressurized component directly exposed to personnel. Examinations for leaks shall be conducted only after the maximum pressure test pressures have been reduced below 2,068 kPa

Table B-1
Test Pressures and Mediums

	Test Pressure kPag (psig)	Test Medium
Unwatering and Filling Piping	689 (100)	Water
Service Air Piping	1,724 (250)	Water
Governor and Lubricating Oil Piping (distribution)	1,551 (225)	Lubricating Oil at 100°F
Generator Cooling Water Piping	689 (100)	Water
Piezometer Piping	1,034 (150)	Water
Low Pressure and Brake Air Piping	1,379 (200)	Air
Governor Air Piping	1 1/2 times Max. Governor Operating Pressure	Water
Potable and Raw Water Piping	1,034 (150)	Water
Gland Water Piping	1,034 (150)	Water
Carbon Dioxide Piping	See above (para B-3*b*)	
Roof Drainage Piping	1.5 m (5 ft) Head at Roof Surface	Water
Drain, Waste, and Vent Piping	3.0 m (10 ft) Head at Floor Surface	Water

(300 psi). Before making the specified pressure test, the contractor shall submit for approval a description of the method to be followed and the type of gas to be used to produce the required pressure for the leakage test.

B-4. Piping System Identification

a. General. All exposed piping and valves including those furnished by the government and by the contractor as specified in other sections shall be identified as herein specified. Identification includes the following:

(1) Piping system designations and flow direction arrows on the piping.

(2) Gauge nameplates.

(3) Painting valve control handles to indicated normal valve position.

b. Piping system designation. Pipes and tubing having an outside diameter including pipe covering of 20 mm (3/4 in.) or larger shall be identified, and the direction of flow indicated on the piping by means of colored prefabricated labels on pressure sensitive self-adhesive cloth tapes. The labels shall have black lettering and flow arrows on a yellow background. The labels shall adhere tightly and neatly on the pipe. Any labels that do not adhere completely shall be removed and reapplied. Letter and arrow size shall comply with the schedule below:

Outside Diameter of Pipe or Covering		Minimum Size of Letter		Minimum Length of Arrow Marker	
mm	(in.)	mm	(in.)	mm	(in.)
20-32	(0.75-1.25)	13	(0.5)	102	(4)
38-51	(1.5-2.0)	19	(0.75)	102	(4)
64-152	(2.5-6.0)	32	(1.25)	178	(7)
203-254	(8.0-10.0)	64	(2.5)	178	(7)
Over 254	(10.0)	89	(3.5)	178	(7)

Piping and tubing less than 20-mm (3/4-in.) outside-diameter shall be identified with engraved laminated sheet plastic or anodized aluminum flow arrows and nameplates with standard Gothic lettering not less than 6 mm (1/4 in.) in height similar to the nameplates used on control centers. Nameplates shall be firmly attached to the piping. The markings shall be applied after cleaning, painting, and insulation of the piping is completed. Identification and direction of flow arrows shall be provided on each side of walls, partitions, floors, or similar barrier which interferes with tracing a line, at all valve locations and near branch lines. Wherever two or more pipes run parallel, the designations shall be applied in the same relative location so as to be in either vertical or horizontal linearity, whichever the case may be. The markings shall be located so as to be readily conspicuous at all times from any reasonable point of vantage but in no case at intervals greater than 14 m (45 ft).

c. Pipe marking schedule. The following marker legends are typical:

RAW WATER-DECK WASHING

RAW WATER-GEN COOLING

RAW WATER-THRUST BEARING

RAW WATER-TURBINE BEARING

RAW WATER-GEN GUIDE BEARING

RAW WATER-TURBINE PKG GLND

RAW WATER-AIR COMPR

CO_2

CO_2-GEN NO. 1

AIR 2590 KPA (375 PSI) GOV

AIR 830 KPA (120 PSI)

AIR 690 KPA (100 PSI) GEN BRAKES

ROOF DRAIN

SPIRAL CASE DRAIN

SPIRAL CASE FILL

TURBINE PIT LINER DRAIN

TURBINE VACUUM BREAKER VENT

LUBE OIL-DRAIN

LUBE OIL-SUPPLY

LUBE OIL-RETURN

LUBE OIL-BYPASS

LUBE OIL-THRUST BEARING

LUBE OIL-TURBINE BEARING

LUBE OIL-GEN GUIDE BRG

LUBE OIL-GEN JACK SUPPLY

LUBE OIL-GEN JACK RETURN

GOV OIL

GOV OIL-RETURN

GOV OIL-SUMP UNIT NO. 1

GOV OIL-SERVO OPEN

GOV OIL-SERVO CLOSE

GOV OIL-TURB BLADES RAISE

GOV OIL-TURB BLADES LOWER

d. Valve tagging. The contractor shall provide approved identifying tags complete with engraved plastic, aluminum, or brass plates with attaching chain for valves in the powerhouse. The government will prepare and furnish to the contractor a list showing the required numbers, letters, and descriptive information to be used for each valve and will mark the piping diagrams indicating their location. The list and marked diagrams will be furnished to the contractor not later than six months prior to the scheduled completion of all work under this contract. The valve list will include all operating and isolating valves installed under this contract and those which are furnished with the government-and contractor-furnished equipment but will exclude check valves, relief valves, gauge cocks, receiver drain valves, valves mounted on control panels, and air and water service connection valves. For estimating purposes, the following may be considered a typical example of the valve designations:

1 - CW - 1, #1 Generator thrust bearing cooling water supply.

Valve tags shall be securely fastened to handwheel-operated valves with approved brass-jointed ball chain approximately 200 mm (8 in.) long, size No. 6, 8 or 10. The chain shall be passed through grommets in the envelope, around the valve stem, and the ends shall be joined together with a reusable coupling. In cases where the valve handwheel is below the valve, the chain shall be passed through the handwheel rather than around the stem. On other than handwheel-operated valves the tags shall be attached by securing the brass ball chain around the valve body with a figure-8 wrap or around a suitable part of the valve.

e. Painting valve handwheels. Valve handwheels or operating levers shall be painted in accordance with the following listed colors to indicate the normal position of the valve:

Normal Operating Position of Valve	Color of Handwheel of Operating Lever
Closed	Red
Open	Green
Either Open or Closed or Throttling	Yellow

B-5. Powerhouse Electric Water Heaters

The method of water heater selection is as follows:

a. Obtaining volume flow rate sum. From Table B-2 below obtain the sum of the volume flow rate served by the heater.

Table B-2
Hot Water Demand

Fixture	Demand L/s	Demand (gph)
Fountain, Wash 1.4m (54 in.)	0.105	(100)
Lavatory	0.008	(8)
Shower	0.105	(100)
Sink, Battery Room	0.021	(20)
Sink, First Aid	0.008	(8)
Sink, Kitchen	0.010	(10)
Sink, Service	0.021	(20)
Conversion Factor:		
Storage	0.30	
Recovery Rate	0.20	

b. Obtaining tank size. Multiply this sum by the storage factor to obtain tank size.

c. Standardized heating elements. Since recovery rate is unlikely to be a factor in powerhouses where demand briefly occurs at lunch time and at end-of-shift, heating elements should be standardized as indicated below.

d. Check recovery rate. In the case of public lavatories where visitor use may be heavy at times, the recovery rate should be checked. Multiply the sum of the volume flow rate (step 1) by the recovery rate demand factor. If this valve exceeds the capacity of standard heaters, then select other heaters or call for simultaneous operation of standard dual elements. The heating capability of standard heaters for a 38°C (100°F) rise are:

2,500-W element - 0.6 L/s (10.2 gpm)
4,500-W element - 1.2 L/s (18.4 gpm)

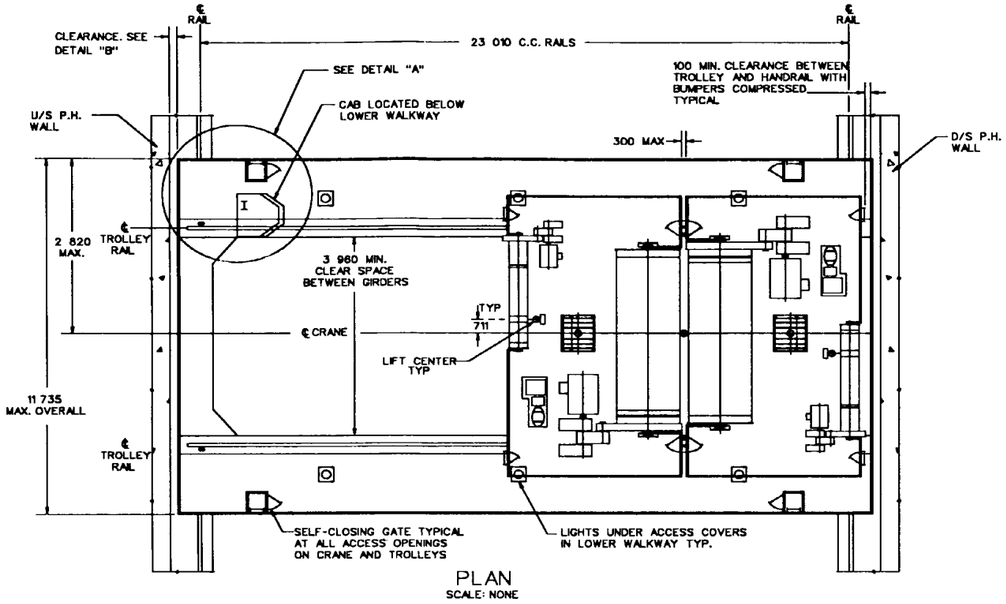
B-6. Capacity of Cast Iron Drain Lines (Water)

The following data are provided to estimate the capacity of gravity drain pipes:

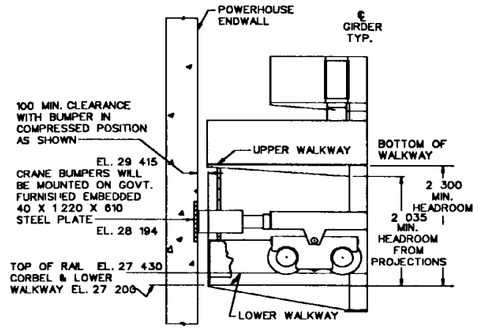
Pipe Inner Diameter	Slope 1%		Slope 2%	
	Velocity	Flow	Velocity	Flow
mm (in.)	m/s (fps)	L/s (gpm)	m/s (fps)	L/s (gpm)
102 (4)	0.6 (1.8)	4.5 (72)	0.8 (2.6)	6 (100)
152 (6)	0.8 (2.5)	14.2 (225)	1.1 (3.6)	20 (315)
203 (8)	1.0 (3.2)	31.5 (500)	1.4 (4.5)	45 (710)
254 (10)	1.2 (3.9)	60.9 (965)	1.7 (5.4)	83 (1310)
305 (12)	1.3 (4.4)	97.2 (1540)	1.9 (6.2)	138 (2190)
381 (15)	1.6 (5.2)	181.7 (2880)	2.3 (7.4)	255 (4050)
457 (18)	1.8 (6.0)	299.7 (4750)	2.6 (8.4)	416 (6600)
533 (21)	2.0 (6.7)	454.2 (7200)	2.9 (9.4)	637 (10100)
610 (24)	2.3 (7.4)	662.4(10500)	3.2(10.4)	927 (14700)
686 (27)	2.5 (8.1)	908.5(14400)	3.4(11.1)	1274 (20200)
762 (30)	2.7 (8.7)	1205.0(19100)	3.7(12.2)	1697 (26900)
914 (36)	3.0 (9.8)	1955.8(31000)	4.2(13.9)	2776 (44000)

Assumed Conditions:

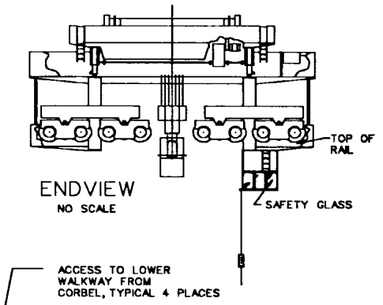
1. Water level a top of pipe at inlet.
2. Free discharge at outlet.
3. Cast iron pipe--coated--good to fair condition. (Also, visitor load applies to concrete or vitrified clay pipe in average condition.)



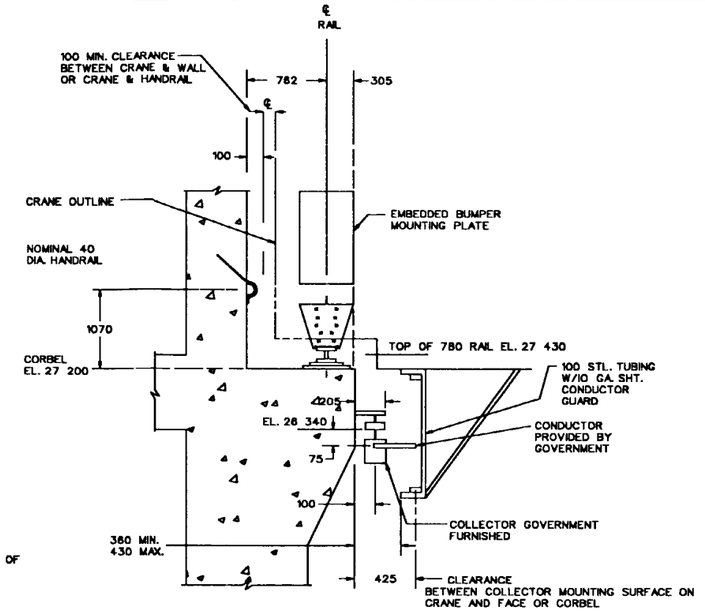
PLAN
SCALE: NONE



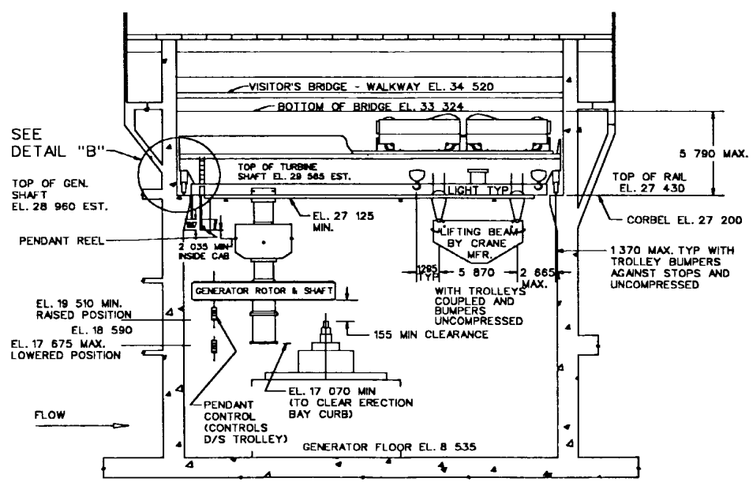
TYP. BUMPER & WALKWAY DETAIL
NO SCALE



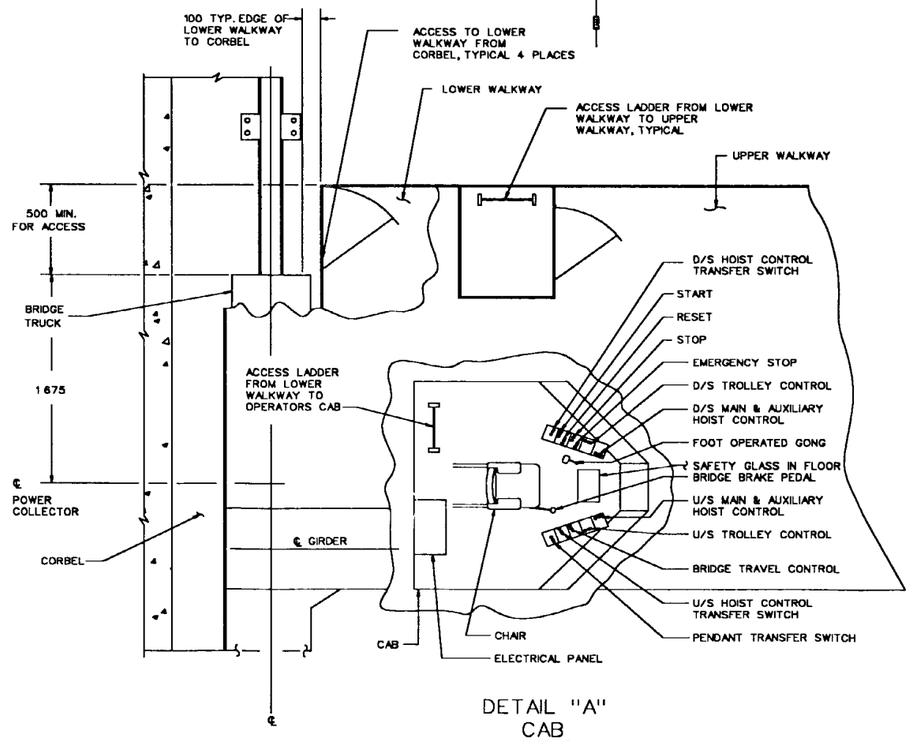
ENDVIEW
NO SCALE



DETAIL "B"
UPSTREAM CORBEL
NO SCALE



POWERHOUSE ELEVATION
NO SCALE



DETAIL "A"
CAB
NO SCALE

CRANE

RATED CAPACITY	4 003KN
MAIN HOIST	
RATED CAPACITY	2 002KN
HOISTING SPEED	19.1-21.6mm/s
HOOK TRAVEL	32 310 MIN.
UPPER LIMIT - ℄ PIN	EL. 27 430 MIN.
LOWER LIMIT - ℄ PIN	EL. - 4878
AUXILIARY HOIST	
RATED CAPACITY	267KN
HOISTING SPEED	140 TO 160mm/s
HOOK TRAVEL	36 730 MIN
UPPER LIMIT - ℄ PIN	EL. 27 890 MIN.
LOWER LIMIT - ℄ PIN	EL. - 8640
TROLLEY	
TRAVEL	11 125
SPEED	180 TO 230mm/s
BRIDGE	
TRAVEL	270 660
SPEED	450 TO 560mm/s
SPAN	23 010

NOTES:
1. PROVISIONS SHOWN ARE TYPICAL FOR AN 8-UNIT PLANT. INITIAL INSTALLATION OF 4-UNITS AND FUTURE INSTALLATION OF 4-UNITS.
2. SEE COVERAGE DIAGRAM PAGE A-19.1.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

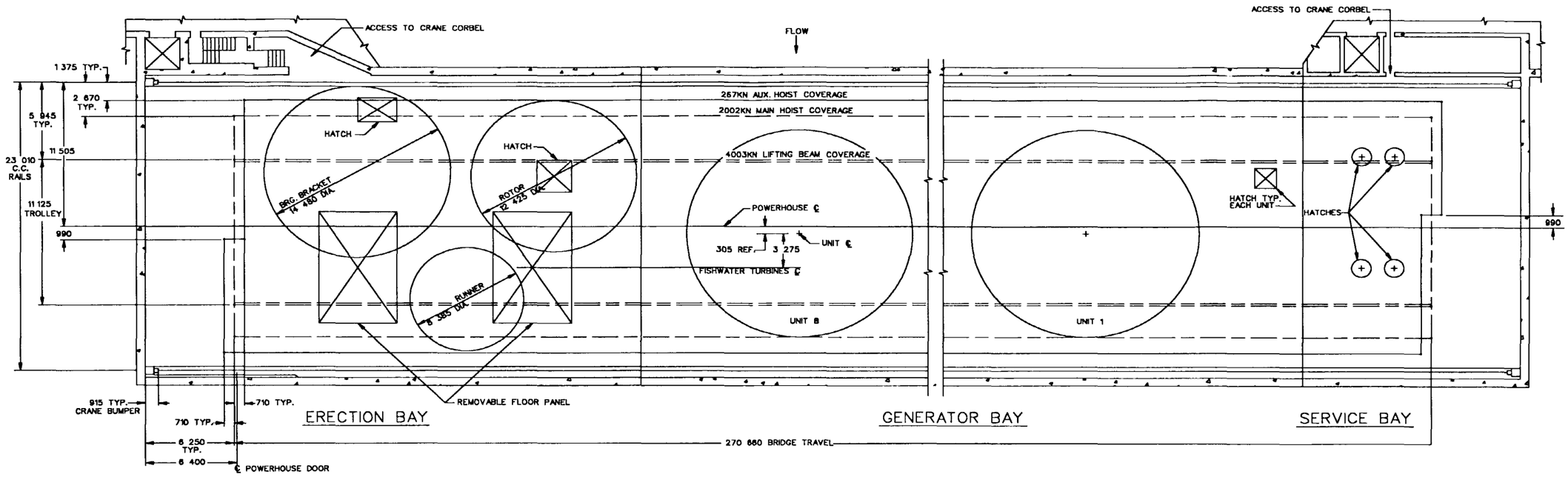
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-1. Bridge crane clearance and coverage (continued)

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.



CRANE COVERAGE DIAGRAM

SCALE: NONE

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

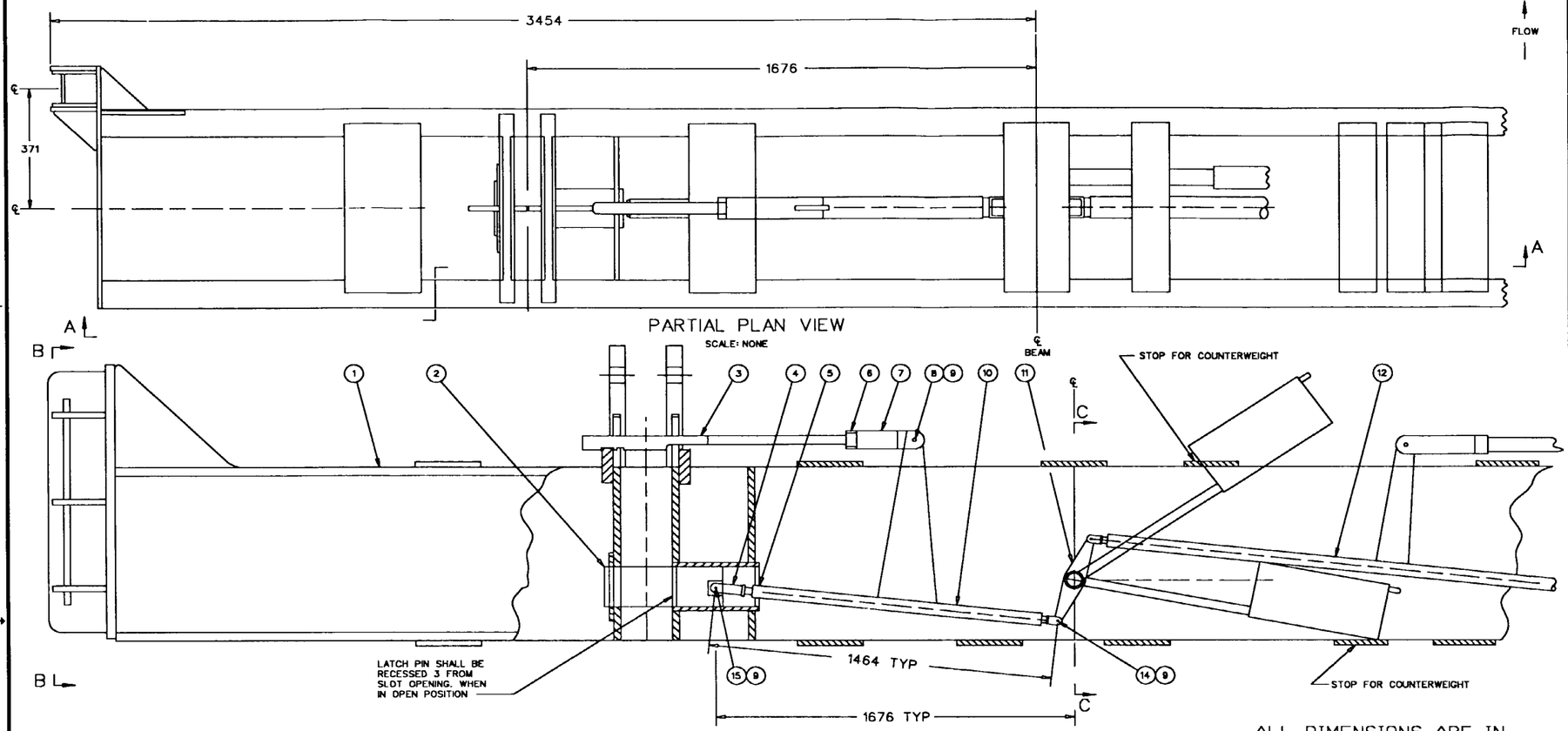
Figure B-1. (Concluded)

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE: AS SHOWN | SHEET NO.

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

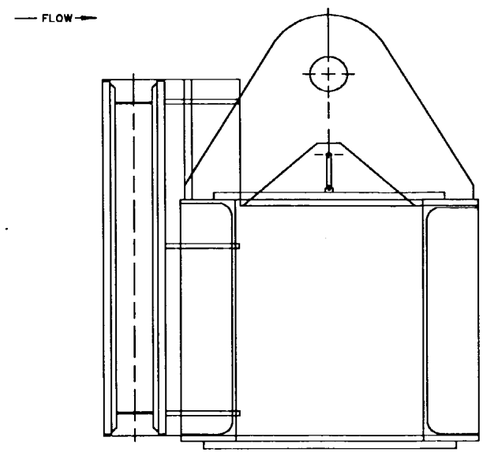


PARTIAL PLAN VIEW

SCALE: NONE

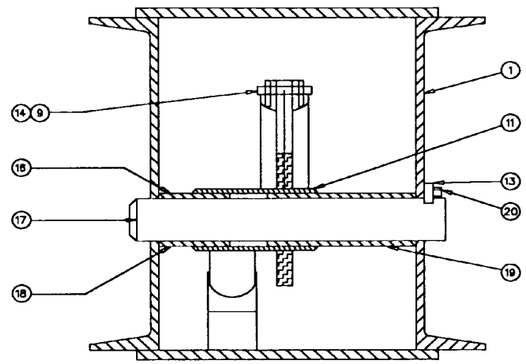
SECTION A-A

SCALE: NONE



VIEW B-B

SCALE: NONE



SECTION C-C

SCALE: NONE

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

PARTS LIST

ITEM NO.	QTY.	DESCRIPTION
1	1	BEAM
2	2	LATCH PIN
3	2	LATCH LOCK
4	2	MALE CLEVIS
5	2	JAM NUT, 3/4 16-UNF-2B, (MATERIAL ---)
6	2	JAM NUT, 1 - 12-UNF-2B, (MATERIAL ---)
7	2	LATCH LOCK CLEVIS
8	2	LATCH LOCK CLEVIS PIN
9	12	RETAINING RING, THRUARC #4100-75-H OR EQUAL
10	1	LATCH ARM
11	1	BELL CRANK
12	1	LATCH ARM
13	1	KEEPER
14	2	LATCH ARM CLEVIS PIN
15	2	CLEVIS PIN
16	2	BELL CRANK BUSHING
17	1	BELL CRANK SHAFT
18	1	BELL CRANK SPACER
19	1	BELL CRANK SPACER
20	2	HEX. HD. CAP SCREW, 10-16 UNC-2A X 25,(MAT'L,---) WITH LOCKWASHER

NOTES:

1. LIFTING BEAM SHOWN IS USED WITH INTAKE GANTRY CRANE TO LIFT INTAKE GATES AND BULKHEADS.
2. LIFTING BEAM DRAWINGS SHOULD CONSIST OF AN ASSEMBLY DWG., FRAME DETAIL DWG. AND PARTS DETAIL DWG.
3. MATERIAL IS SHOWN ON DETAIL OR PARTS LIST.
4. LINE BORING TO BE DONE AFTER FABRICATION OF FRAME WELDMENT.
5. THE LATCH MECHANISM CONSISTS OF A COUNTERWEIGHT, A BELLCRANK, LATCH ARMS, LATCH PINS, AND LATCH LOCKS. THE LATCH LOCKS CAN LOCK THE MECHANISM IN EITHER THE LATCHED OR UNLATCHED POSITION. BOTH GATE LIFTING EARS MUST BE PROPERLY ENGAGED IN THE LIFTING BEAM TO RELEASE BOTH LOCKS BEFORE THE MECHANISM CAN BE MOVED. WHEN BOTH LOCKS ARE RELEASED, THE LATCH MECHANISM CAN BE ENGAGED BY MOTION OF THE COUNTERWEIGHT, OR DISENGAGED BY THE LATCH MECHANISM.
6. THE LATCH RELEASE MECHANISM CONSISTS OF A DUAL-TORQUE (OR TWO SINGLE-TORQUE) TORQUE MOTOR(S) CONNECTED TO A SMALL HOIST DRUM WITH CABLE TO OPERATE THE LATCH MECHANISM BY RAISING THE COUNTERWEIGHT. WHEN POWER IS OFF, A SPRING-SET, MAGNET RELEASED BRAKE PREVENTS DRUM ROTATION. WHEN POWER IS ON, THE BRAKE IS RELEASED AND THE TORQUE MOTOR IS ENERGIZED AT LOW TORQUE TO KEEP THE HOIST CABLE TAUGHT DURING BOTH RAISING AND LOWERING OF THE LIFTING BEAM. TO UNLATCH, OR TO HOLD THE MECHANISM UNLATCHED, THE TORQUE MOTOR IS SWITCHED TO HIGH TORQUE WHICH LIFTS THE COUNTERWEIGHT AND RETRACTS THE LATCH. THE LIFTING BEAM MAY BE MOVED EITHER UP OR DOWN WITH THE TORQUE MOTOR(S) AT EITHER HIGH OR LOW SETTING. WHEN THE TORQUE MOTOR IS SWITCHED FROM HIGH TO LOW TORQUE, COUNTERWEIGHT LOWERS AND THE LATCH ENGAGES.

REVISION	DATE	DESCRIPTION	APPROVED
			CHIEF, ENGINEERING
			CHIEF, DRAWING
			CHIEF,

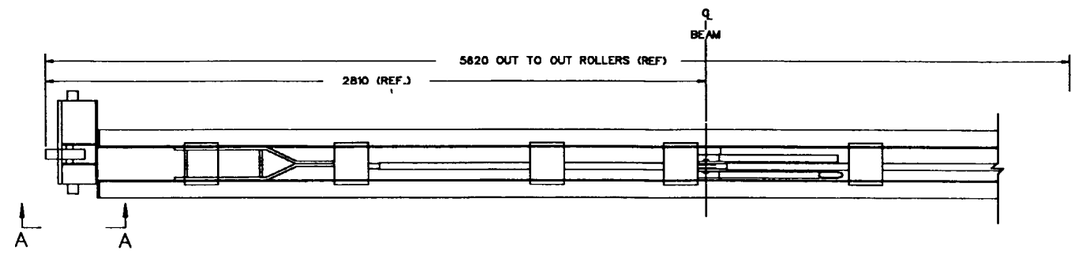
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:
CHIEF,

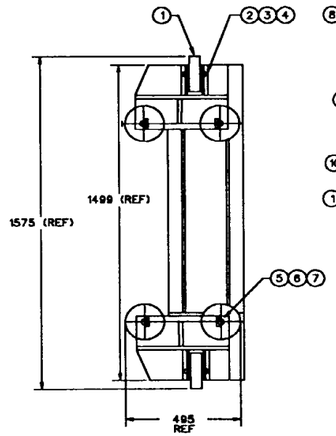
Figure B-2. Intake gate and bulkhead lifting beam

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

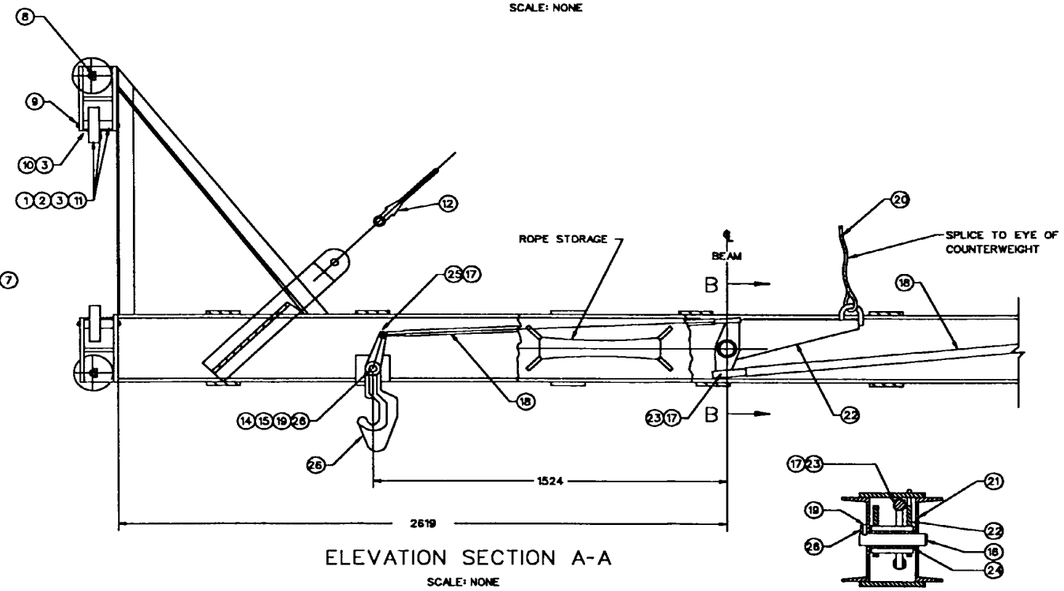
SCALE AS SHOWN | SHEET NO.
DWG NO.



PARTIAL PLAN VIEW
SCALE: NONE



END VIEW
SCALE: NONE



ELEVATION SECTION A-A
SCALE: NONE

SECTION B-B
SCALE: NONE

PARTS LIST

ITEM NO.	QTY.	DESCRIPTION
1	12	ROLLER
2	24	SLEEVE BEARING
3	24	PLAIN WASHER, 28 ID x 38 OD x 4.8 (MATL--)
4	8	SPACER, 25 STD. PIPE x 19.8 LONG
5	12	KEEPER
6	24	HVY LOCK WASHER, 10, (MAT'L --)
7	24	CAP SCREW, 10 - 16 UNC-2A x 20, (MAT'L ---)
8	4	ROLLER SHAFT
9	8	ROLLER SHAFT
10	8	SPACER, 25 STD PIPE x 15.1 LONG
11	8	SPACER, 25 STD PIPE X 58.4 LONG
12	1	TWO LEG BRIDLE SLING - WICKWIRE (CF & I) ASSEMBLY "A" WITH STYLE TOS LEGS, 2440 LONG x 25 VERY IMPROVED PLOW STEEL WITH IWRC WIRE ROPE OR EQUAL
13	2	HOOK
14	2	HOOK SHAFT
15	4	HOOK BUSHING
16	1	BELL CRANK SHAFT
17	8	RETAINING RING TRUARC #5100-75-H OR EQ.
18	2	LATCH ARM
19	3	KEEPER
20	1	ROPE POLYPROPYLENE 15 DIA x 23000 MIL-R-24949A
21	1	BEAM
22	1	BELL CRANK & COUNTERWEIGHT
23	2	LATCH ARM CLEVIS PIN
24	2	BELL CRANK BUSHING
25	2	CLEVIS PIN
26	6	CAP SCREW, 10 X 25, (MAT'L---) WITH LOCKWASHER GALV.

NOTES:

1. LIFTING BEAM IS TYPICAL FOR LIFTING TRASH RACKS, BULKHEADS, GATES AND STOPLOGS. WEIGHT OPERATED LATCHING AND MANUAL RELEASE CRANK LEVER HANDLE WEIGHT PROVIDES TORQUE FOR LATCHING. TAG LINE PROVIDES MEANS FOR UNLATCHING.
2. "SKIN PLATE" DESIGNATION REFERS TO BULKHEAD SKIN PLATE FOR PROPER ORIENTATION OF BEAM.
3. LIFTING BEAM DRAWINGS SHALL CONSIST OF AN ASSEMBLY DWG, BEAM DETAIL DWG, AND PARTS DETAIL DWG.
4. MATERIAL IS SHOWN ON DETAIL OR PARTS LIST.
5. LINE BORING TO BE DONE AFTER FABRICATION OF FRAME WELDMENT.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

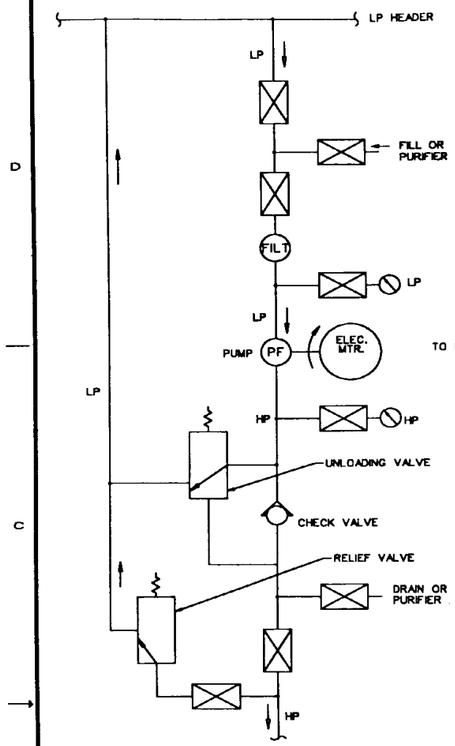
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

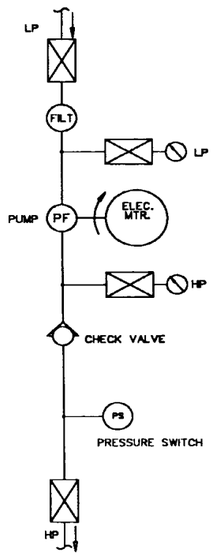
Figure B-3. Lifting beam manual hook release type

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

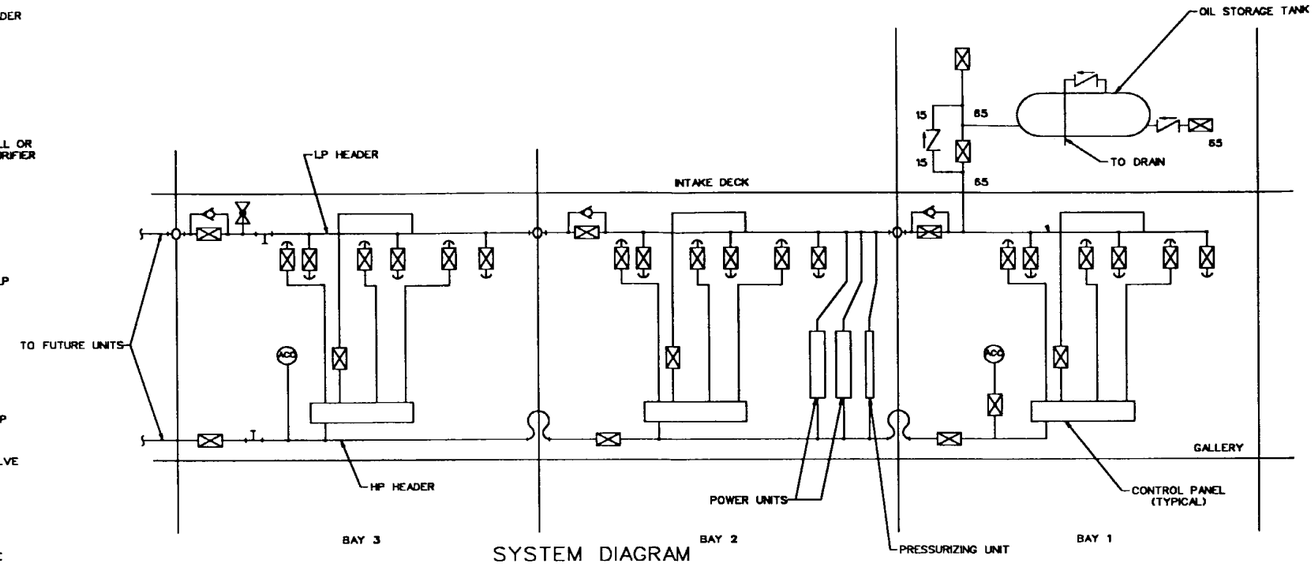
SCALE AS SHOWN | SHEET NO.
DWG NO.



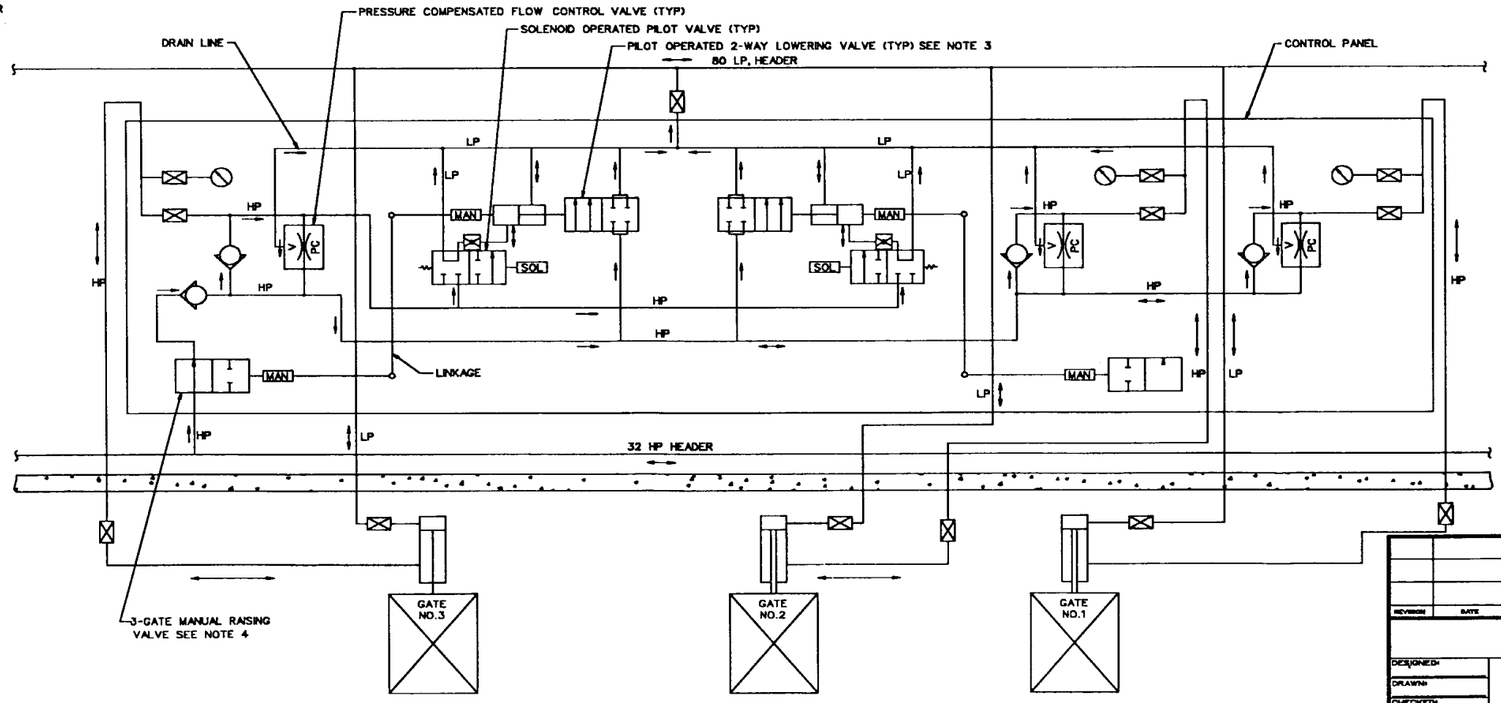
POWER UNIT DIAGRAM



PRESSURIZING UNIT DIAGRAM



SYSTEM DIAGRAM



GATE CONTROL DIAGRAM

	MANUAL SHUT-OFF VALVE - NORMALLY OPEN
	MANUAL SHUT-OFF VALVE - NORMALLY CLOSED
	LP EXPANSION JOINT
	HP EXPANSION JOINT
	LINES THRU HEADWALL

NOTES:

1. SYSTEM SHOWN IS TYPICAL OF A 6-UNIT KAPLAN PLANT WITH 3-GATES PER UNIT,3 UNITS IN INITIAL INSTALLATION AND 3 FUTURE UNITS.
2. GATES ARE NORMALLY SUPPORTED IN OPEN POSITION BY OIL IN CYLINDER WITH SYSTEM PRESSURE MAINTAINED ABOVE MINIMUM NO-DRIFT PRESSURE BY PRESSURIZING UNIT.
3. 2 LOWERING VALVES CONNECTED IN PARALLEL LOWER ALL 3 GATES WITH AUTOMATIC BACK UP FOR INOPERATIVE VALVE. VALVES SHOWN ARE 4-WAY VALVES CONNECTED AS 2-WAY FOR HIGHER FLOW CAPABILITY.
4. MANUAL RAISING VALVE IS NORMALLY OPEN BUT IS CLOSED PRECEDING NORMAL GATE CLOSURES AND FOLLOWING EMERGENCY CLOSURES.
5. FOR CYLINDER DETAIL SEE PAGE A-23.
6. GRAPHIC SYMBOLS SHOULD CONFORM TO ANSI STADARDS.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

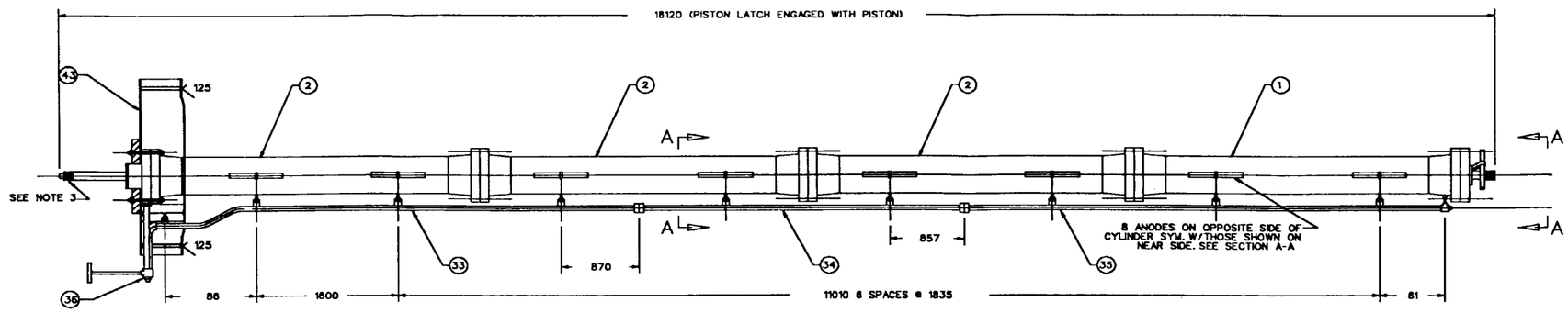
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

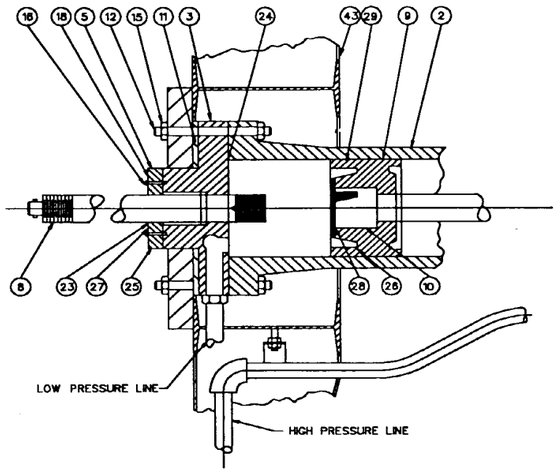
SCALE AS SHOWN | SHEET NO.

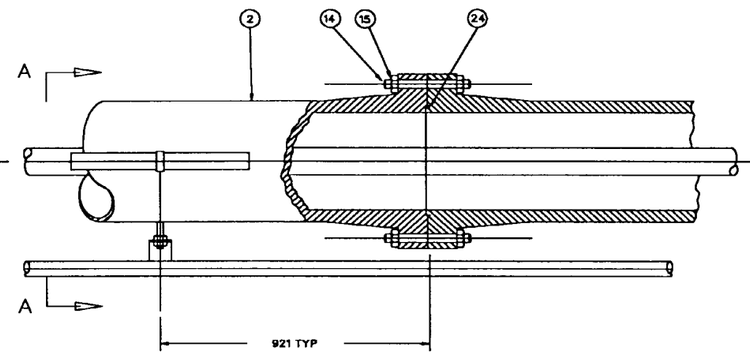
Figure B-4. Intake gate hoist hydraulic system



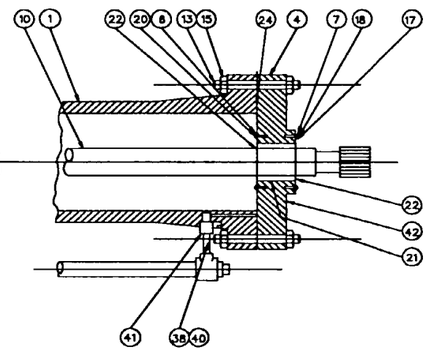
CYLINDER & SUPPORT BEAM ASSEMBLY
SCALE: 1:20

ITEM NO.	QTY.	DESCRIPTION
1	1	CYLINDER SECTION
2	3	CYLINDER SECTION
3	1	UPPER CYLINDER HEAD
4	1	LOWER CYLINDER HEAD
5	1	UPPER HEAD GLAND
6	1	LOWER HEAD BEARING
7	1	LOWER HEAD GLAND
8	1	PISTON LATCH
9	1	PISTON
10	1	PISTON ROD
11	1	SPACER
12	16	38.1 DIA. STUD BOLT (MATL. -----)
13	16	38.1 DIA. STUD BOLT (MATL. -----)
14	48	38.1 DIA. STUD BOLT (MATL. -----)
15	176	NUT, HEX, SEMI-FIN, 38.1-8N-2B HVY. (MATL. -----)
16	8	UPPER GLAND STUD (MATL. -----)
17	8	LOWER GLAND STUD (MATL. -----)
18	12	FIN HEX NUT, 19.05-10 UNC-2B (MATL. -----)
19	53	NUT, HEX, SEMI - FIN, 12.7-13UNC-2B (MATL. -----)
20	8	FINCAP SCREW, 15.88-11 UNC-2A X 2 (MATL. -----)
21	1 SET	119 I.D. X 150.81 O.D. "V" RING PACKING W/5 RINGS & ADAPTERS GARLOCK NO. 431 OR EQUAL
22	2	198.08 ROD DIA. WIPER-HYD. ACCESS. CO. "SEAL GUARD" NO. 3438 OR EQUAL
23	1	104.87 ROD DIA. WIPER - HYD. ACCESS. CO. "SEAL GUARD" NO. 3437 OR EQUAL
24	5	381 I.D. X 8.4 DIA. "O" RING-"NATIONAL NO. 822788 OR EQ.
25	1	171.5 I.D. X 8.4 DIA. "O" RING-"NATIONAL" NO. 822787 OR EQ.
26	1	158.8 I.D. X 8.4 DIA. "O" RING-"NATIONAL" NO. 822765 OR EQ.
27	1	104.8 I.D. X 4.78 DIA. "O" RING-"NATIONAL" NO. 822749 OR EQ.
28	1	158.8 DIA. MSG. BORE INTERNAL RETAINING RING -WALDES "TRUARC" NO. N5000-625 OR EQUAL
29	5	381.95 BORE DIA. W/ 11.11 X 12.7 SECTION PISTON RING KOPPERS CO. INC. "SPECIAL STEP SEAL" PART NO. 37968 OR EQUAL
30	17	MAGNESIUM ANODE 50.8 DIA. X 609.6 LONG
31	17	ANODE CLAMP
32	17	BOLT, HEX HD. 12.7 -13 UNC -2A X 1 1/4 (MATL. ----
33	1	HP LINE - TOP SECTION
34	1	HP LINE - CENTER SECTION
35	1	HP LINE BOTTOM SECTION
36	1	LP LINE ASSEMBLY
37	17	SCREW, SELF TAPPING NO. 10 X 1 W/ TOOTH LOCK WASH.
38	2	STUD, 15.875 DIA. 73.025 (MATL. -----)
39	33	1/2" EXTERNAL TOOTH LOCK WASHER (MATL. -----)
40	2	NUT, HEX 3/8-11 UNC-2B (MATL. -----)
41	1	44.45 I.D. X 4.7825 DIA. "O" RING-"NATIONAL NO. 822730 OR EQ.
42	1	PLUG, PIPE, SQ. HD. 3/4 NPT
43	1	CYLINDER SUPPORT BEAM



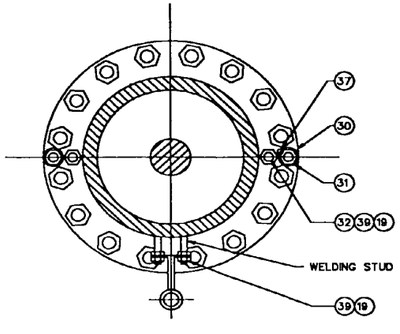


PARTIAL SECTION
SCALE: 1:10

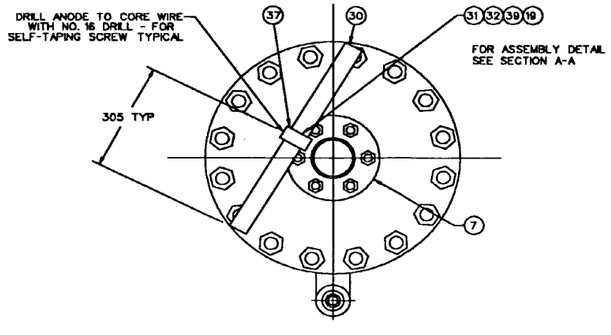


NOTES:
1. CYLINDER SHOWN IS TYPICAL FOR A 8-UNIT KAPLAN PLANT WITH 3-20" X 50" INTAKE GATES PER UNIT. NOMINAL SYSTEM. HYDRAULIC PRESSURE-2000 P.S.I. MAX. PRESSURE-3000 P.S.I.
2. CYLINDER ROD COUPLED TO INTAKE GATE STUB ROD WITH SPECIAL COUPLING NUT.
3. CYLINDER PISTON LATCH IS OPERATED WITH EXTENDED T-WRENCH AND IS USED TO SECURE GATE IN OPEN POSITION. FOR MAINTENANCE AND FOR RAISING GATE - CYLINDER ASSEMBLY WITH INTAKE GANTRY CRANE.
4. MATERIAL IS SHOWN ON DETAIL OR PARTS LIST.
5. SEE HYDRAULIC SYSTEM DIAGRAM PAGE A-22.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE



SECTION A-A
SCALE: 1:5



VIEW A-A
SCALE: 1:5

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

REVISION	DATE	DESCRIPTION	APPROVED

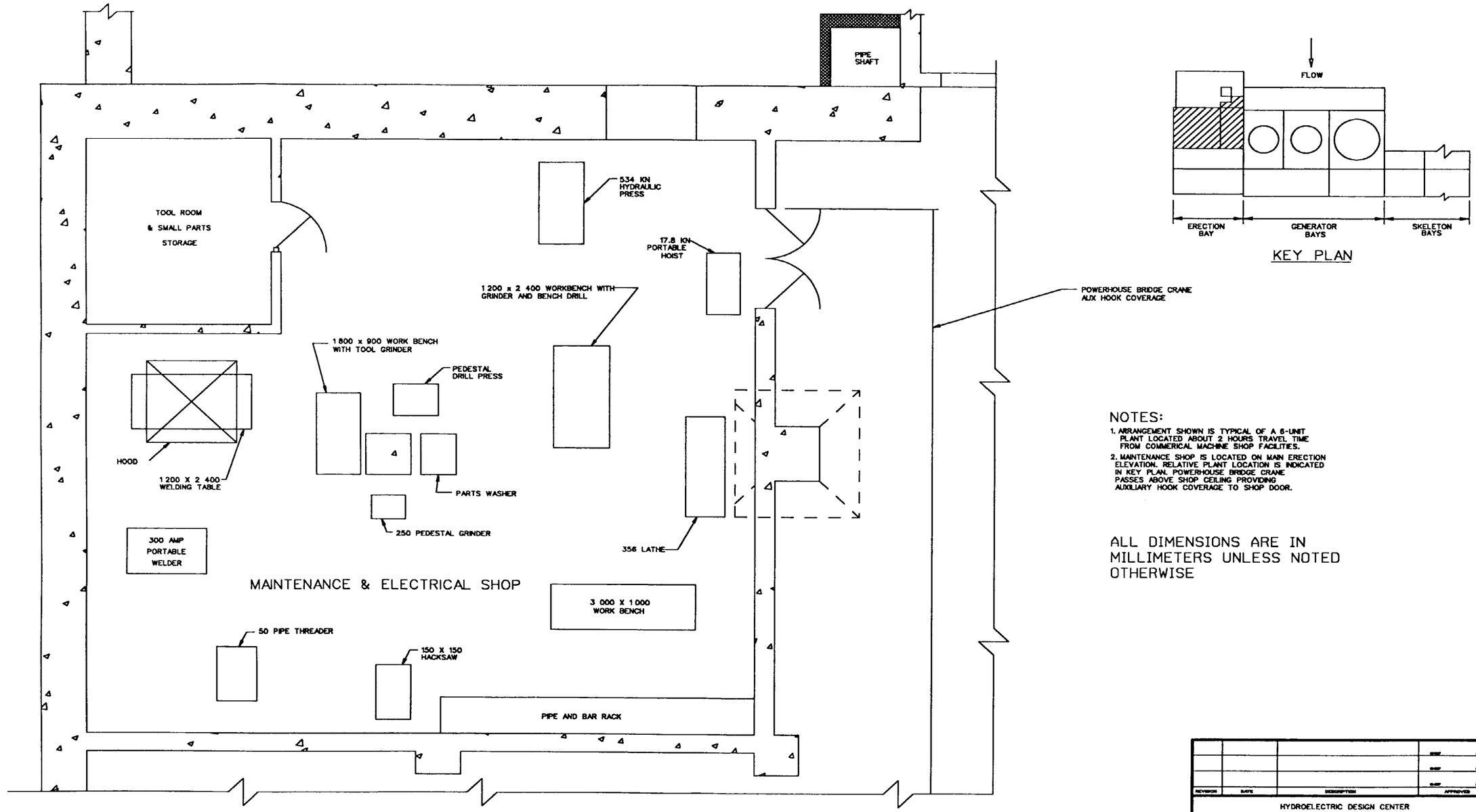
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-5. Intake gate hoist cylinder assembly

SUBMITTED:
GLENN R. MELOY, P.E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.



PLAN

KEY PLAN

NOTES:

1. ARRANGEMENT SHOWN IS TYPICAL OF A 6-UNIT PLANT LOCATED ABOUT 2 HOURS TRAVEL TIME FROM COMMERICAL MACHINE SHOP FACILITIES.
2. MAINTENANCE SHOP IS LOCATED ON MAIN ERECTION ELEVATION. RELATIVE PLANT LOCATION IS INDICATED IN KEY PLAN. POWERHOUSE BRIDGE CRANE PASSES ABOVE SHOP CEILING PROVIDING AUXILIARY HOOK COVERAGE TO SHOP DOOR.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED
			CHIEF, ENGINEER
			CHIEF, DRAWING
			CHIEF, DRAWING

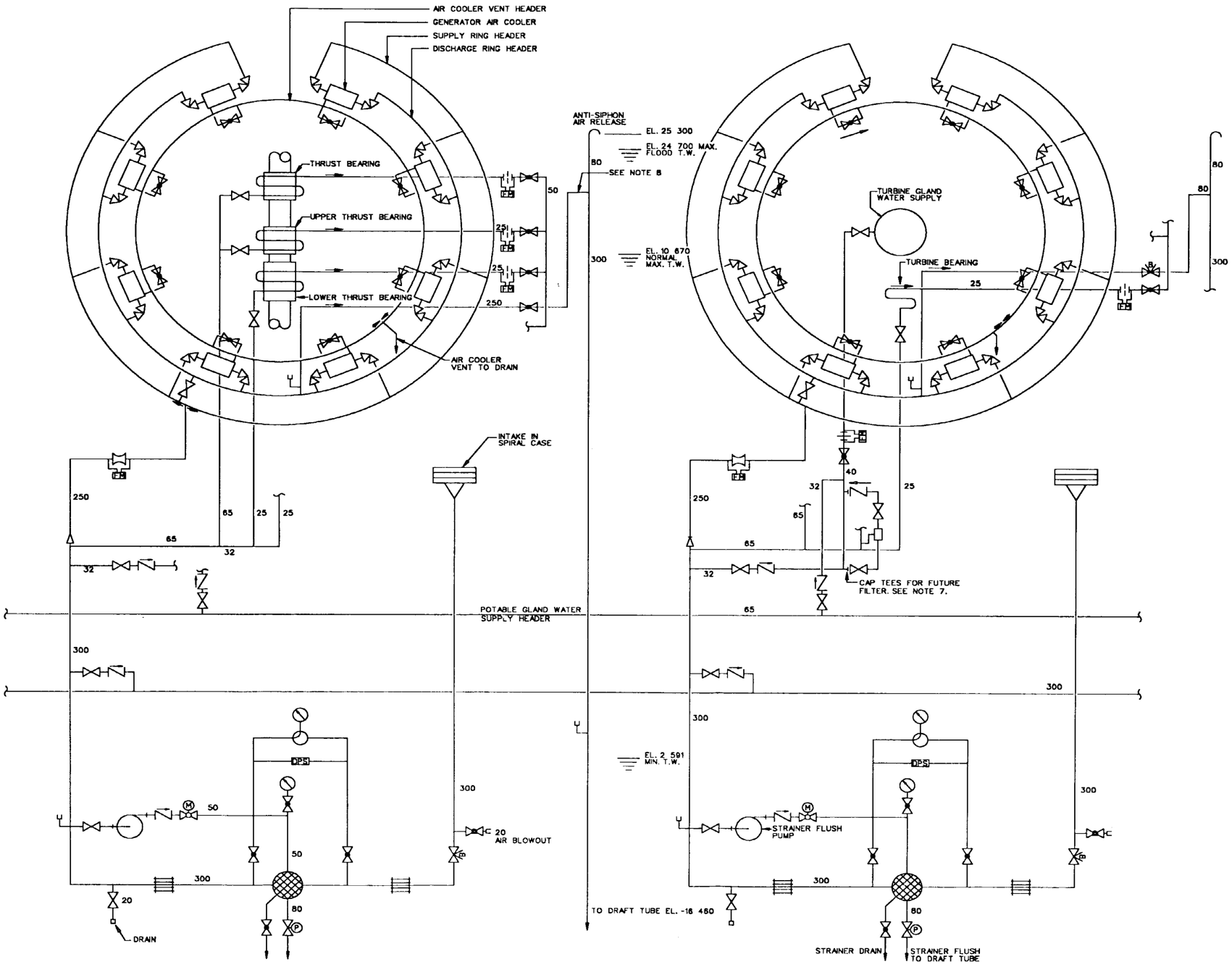
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED
DRAWN
CHECKED
PREPARED
CHIEF

Figure B-6. Maintenance shop arrangement

SUBMITTED
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.



TYPICAL MAIN UNIT SHOWING GENERATOR GUIDE AND THRUST BEARING COOLING WATER

TYPICAL MAIN UNIT SHOWING TURBINE GLAND AND TURBINE BEARING COOLING WATER

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

SYMBOLS

	GATE VALVE
	GLOBE VALVE
	CHECK VALVE
	ANGLE VALVE
B	BUTTERFLY VALVE
C	BALL VALVE W/ UNIVERSAL AIR HOSE CONNECTION
M	MOTORIZED BALL VALVE
	VENTURI TUBE
P	PULP STOCK VALVE
	ORIFICE FLANGE
FM	FLOW METER
	COOLING COIL
	REDUCER
	SELF-CLEANING STRAINER
DPS	DIFFERENTIAL PRESSURE SWITCH
	PRESSURE GAGE
	INTAKE GRATING
	3-WAY, 2-PORT, 90° PLUG VALVE
	SLEEVE TYPE COUPLING
F	FILTER
	CENTRIFUGAL PUMP
	THERMOMETER WELL
	HOSE ADAPTER W/ CAP & CHAIN

NOTES:

1. SYSTEM SHOWN IS TYPICAL OF AN 8-UNIT KAPLAN PLANT WITH GRAVITY SUPPLY FROM SPIRAL CASE TO GENERATOR AND TURBINE COOLERS.
2. RAW WATER HEADER SUPPLIES COOLING WATER FOR HEAT AND VENT, RAW WATER SYSTEMS AND STANDBY WATER TO UNIT WHEN STAINER OR INTAKE IS OUT OF SERVICE.
3. PROVIDE A WARM WATER HEADER CONNECTING TO AT LEAST 3 UNITS WITH MODULATED AIR COOLER FLOWS WHEN HEAT AND VENT SYSTEM REQUIRES A WARM WATER SOURCE.
4. UNSHADED VALVES - NORMALLY OPEN, SHADED VALVES NORMALLY CLOSED.
5. FOR RAW WATER SYSTEM SEE PAGE A-3
6. FOR COOLING WATER SYSTEM IN SMALL HIGH HEAD PLANT SEE PAGE A-2
7. POTABLE WATER SYSTEM HAS CURRENT FULL RELIABILITY FOR GLAND WATER
8. HIGH POINT OF VENTED DISCHARGE LOOP SHOULD BE ABOVE NORMAL MAX. TAILWATER AND ABOVE DISCHARGE RING HEADER.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	DSGN	DRAWN	CHKD	APPROVED

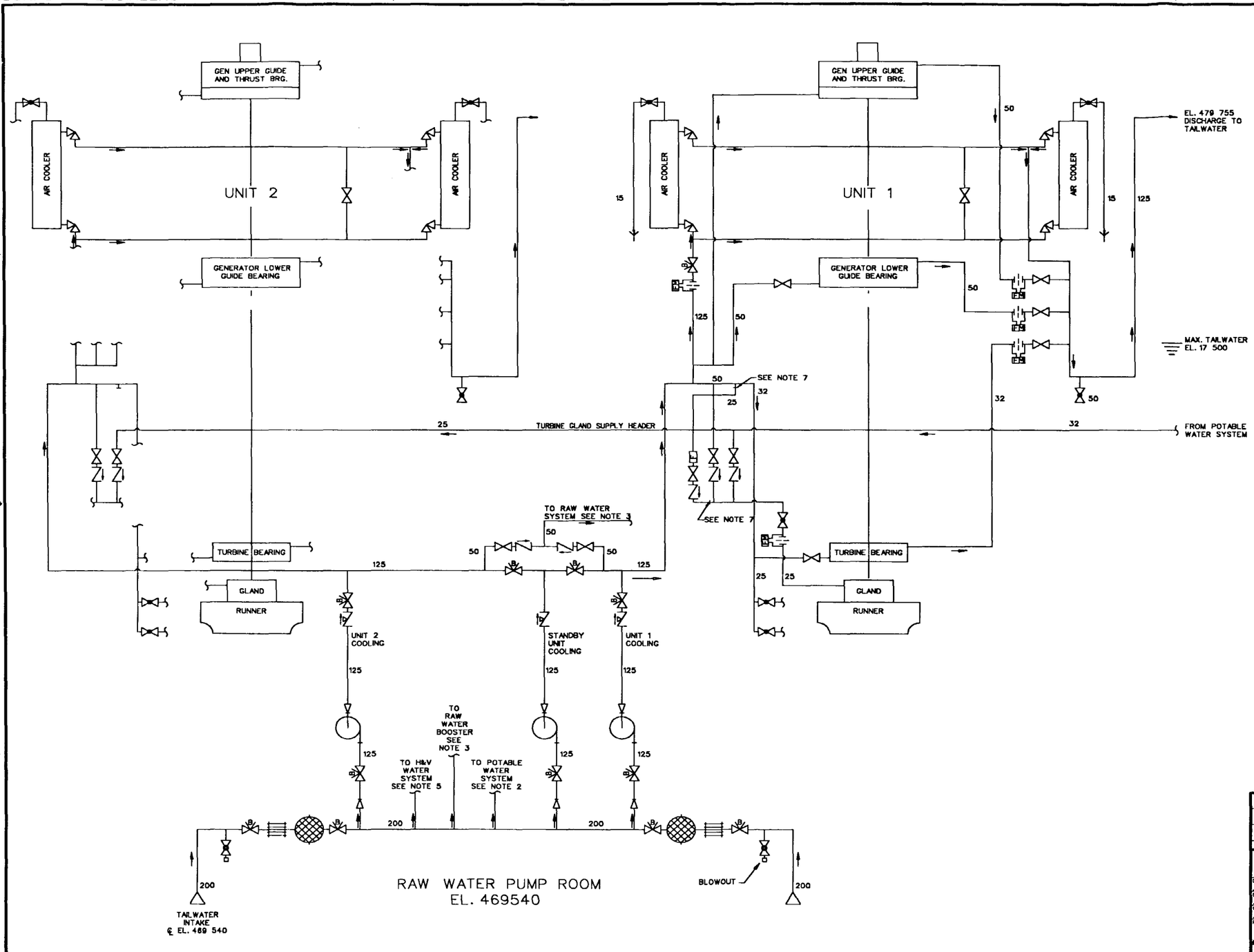
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:
DATE:

Figure B-7. Main unit cooling water system (Continued)

SUBMITTED:
GLENN R. MELOY, P.E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE: AS SHOWN | SHEET NO.
DWG NO.



SYMBOLS	
	GATE VALVE
	GLOBE VALVE
	CHECK VALVE, SWING
	CHECK VALVE, LIFT
	BUTTERFLY VALVE
	BALL VALVE W/ HOSE ADAPTER W/ CAP AND CHAIN
	SINGLE BASKET STRAINER
	SIGHT FUNNEL
	WATER INTAKE, GRATED
	CENTRIFUGAL PUMP
	ORIFICE FLANGE
FM	FLOW METER
	SLEEVE TYPE COUPLING
	ANGLE VALVE

NOTES:

1. SYSTEM SHOWN IS TYPICAL OF A 2-UNIT (FRANCIS) PLANT WITH PUMPED SUPPLY FROM TAILWATER PROVIDING ALL PLANT WATER REQUIREMENTS.
2. FOR POTABLE WATER SYSTEM SEE PAGE A-5.
3. FOR RAW WATER SYSTEM SEE PAGE A-4.
4. FOR COOLING WATER SYSTEM IN LARGE LOW HEAD PLANT SEE PAGE A-1.
5. HEAT & VENT SYSTEM IN THIS PLANT UTILIZES RAW WATER FOR COOLING COILS.
6. UNSHADED VALVES-NORMALLY OPEN, SHADED VALVES - NORMALLY CLOSED.
7. TEES FOR INTALLATION OF FUTURE FILTER IF REQUIRED.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

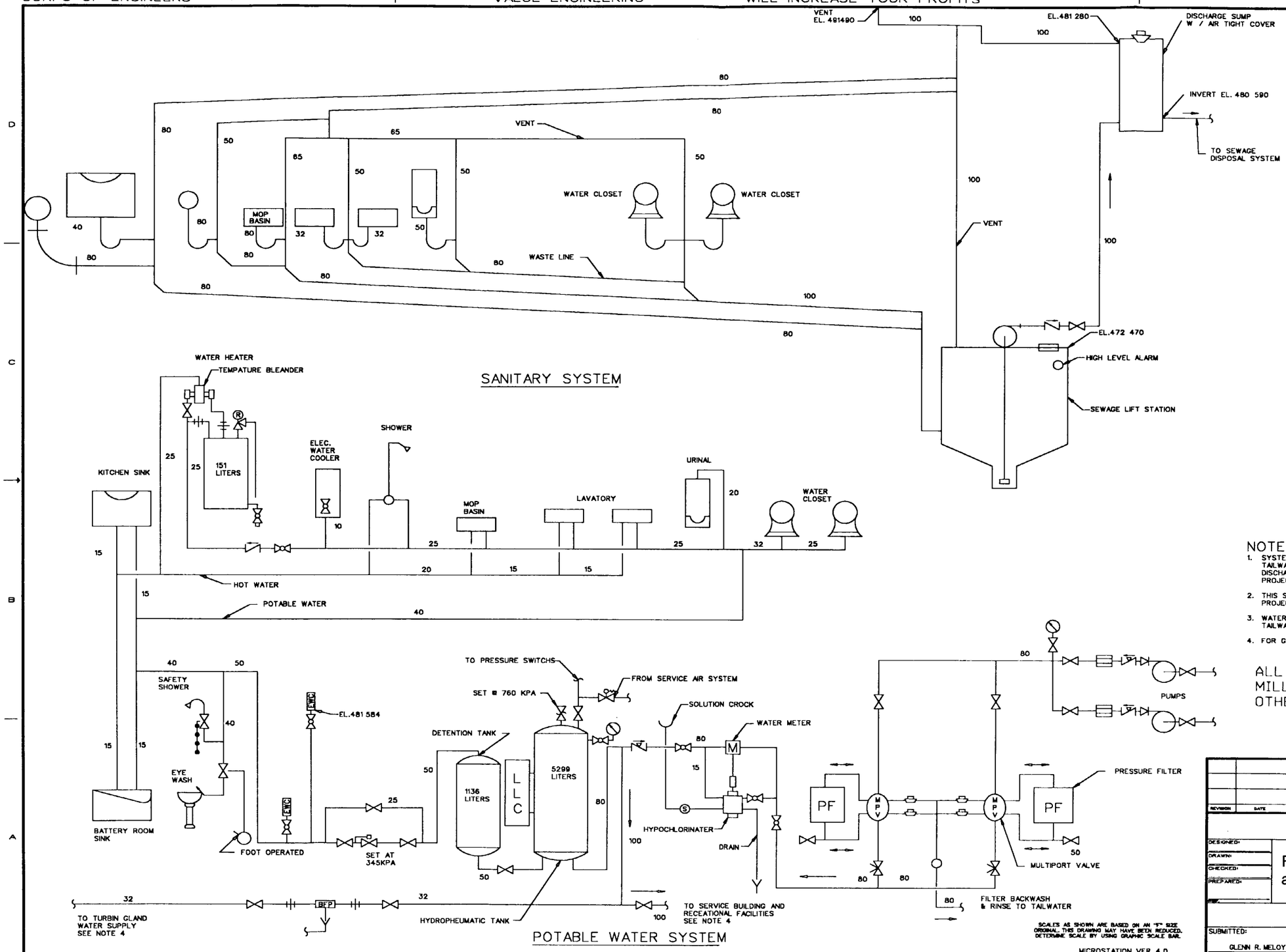
Figure B-7. (Concluded)

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.

SCALES AS SHOWN ARE BASED ON AN "E" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0



SYMBOLS	
	GATE VALVE
	GLOBE VALVE
	CHECK VALVE, SWING
	CHECK VALVE, LIFT
	GATE VALVE W/ HOSE CONNECTION
	SIGHT FUNNEL
	SOLENIOD CONTROLLED VALVE
	THERMOSTATIC CONTROLLED VALVE
	THERMOMETER
CO	CLEANOUT
	SHOWER HEAD
	PRESSURE GAGE
	PRESSURE RELIEF VALVE
	PRESSURE & TEMP. RELIEF VALVE
	PRESSURE SAFETY VALVE
BPV	BACK PRESSURE VALVE
	SPRING LOADED VALVE, FOOT CONTROLED
	BUTTERFLY VALVE
BFP	BACK FLOW PREVENTER
	PRESSURE REDUCING VALVE W/ STRAINER
	PLUG VALVE, 3-WAY 3-PORT, HOSE CONN.
T	TEMPERATURE RELIEF VALVE
EWC	ELECTRIC WATER COOLER
P	PRESSURE SWITCH
S	SIGHT GLASS
LLC	LIQUID LEVEL CONTROL
	Y-TYPE STRAINER
	COCK, WRENCH-HEAD, 2-WAY

NOTES:
1. SYSTEMS SHOWN ARE TYPICAL OF A SMALL PLANT USING TAILWATER AS A SOURCE FOR POTABLE WATER AND DISCHARGING UNTREATED POWERHOUSE SEWAGE TO A PROJECT TREATMENT PLANT.
2. THIS SYSTEM SUPPLIES POTABLE WATER TO OTHER PROJECT FACILITIES.
3. WATER COOLERS AND BATERY ROOM FIXTURES DRAIN TO TAILWATER OR DRAINAGE SYSTEM.
4. FOR GLAND WATER SYSTEM SEE PAGE A-1 AND A-2.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

REVISION	DATE	DESCRIPTION	APPROVED

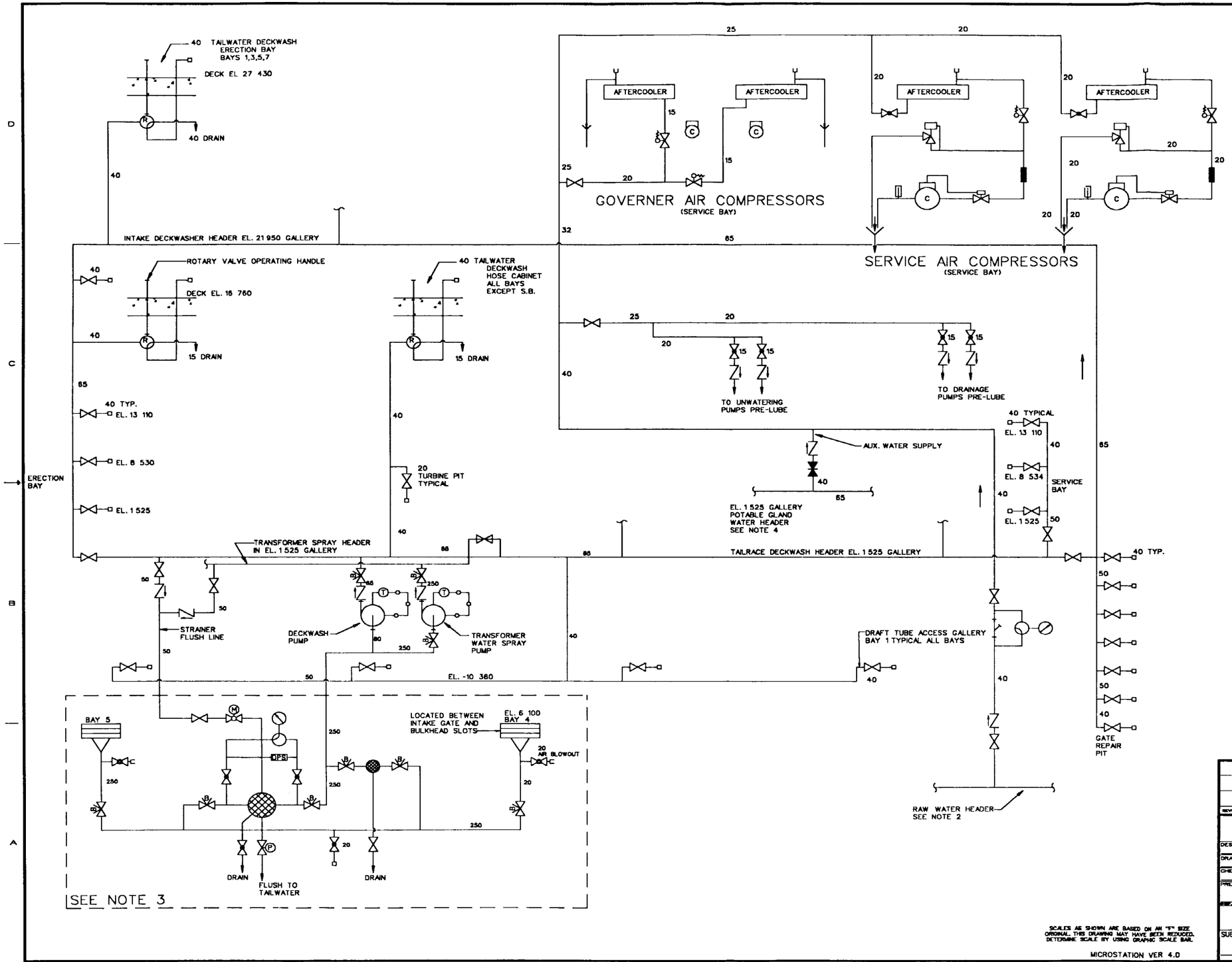
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-8. Potable water and sanitary systems

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.



SYMBOLS

	GATE VALVE
	GLOBE VALVE
	3-WAY 3-PORT PLUG VALVE
B	BUTTERFLY VALVE
C	BALL VALVE W/ UNIVERSAL AIR HOSE CONNECTION
M	MOTOR OPERATED BALL VALVE
S	SOLENIOD CONTROLLED VALVE
T	THERMOSTAT CONTROLLED VALVE
	PLUG VALVE 3-WAY 2-PORT 180°
	CHECK VALVE
	INTAKE
	SELF-CLEANING STRAINER
	Y-TYPE STRAINER
C	AIR COMPRESSOR
BPV	BACK PRESSURE VALVE
	SIGHT FUNNEL
	PRESSURE GAGE
	FLEXIBLE CONNECTOR
	HOSE ADAPTER W/ CAP & CHAIN
	THERMOMETER WELL
	THERMOMETER
	INTAKE GRATING
P	PULP STOCK VALVE
	SINGLE BASKET STRAINER
T	ELECTRIC THERMOSTAT
R	ROTOR VALVE 3-WAY 2 PORT 90°
DPS	DIFFERENTIAL PRESSURE SWITCH

NOTES:

1. SYSTEM SHOWN IS TYPICAL OF AN 8-UNIT KAPLAN PLANT WITH INTAKE STRUCTURE AND GATES PART OF THE POWERHOUSE.
2. FOR RAW WATER HEADER SEE PAGE A-1
3. ALTERNATE INTAKE FOR DECK WASH AND TRANSFORMER SPRAY PUMPS WOULD BE RAW WATER HEADER.
4. POTABLE WATER IS SUPPLED FROM LARGE GRAVITY TANK. (NON-POWERHOUSE)
5. DECK WASH HOSES PROVIDE BACK-UP FIRE PROTECTION. TRANSFORMER SPRAY PUMP PROVIDES BACK-UP FOR DECK WASH PUMP.
6. UNSHADED VALVES - NORMALLY OPEN, SHADED VALVES NORMALLY CLOSED.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-9. Raw water system (Continued)

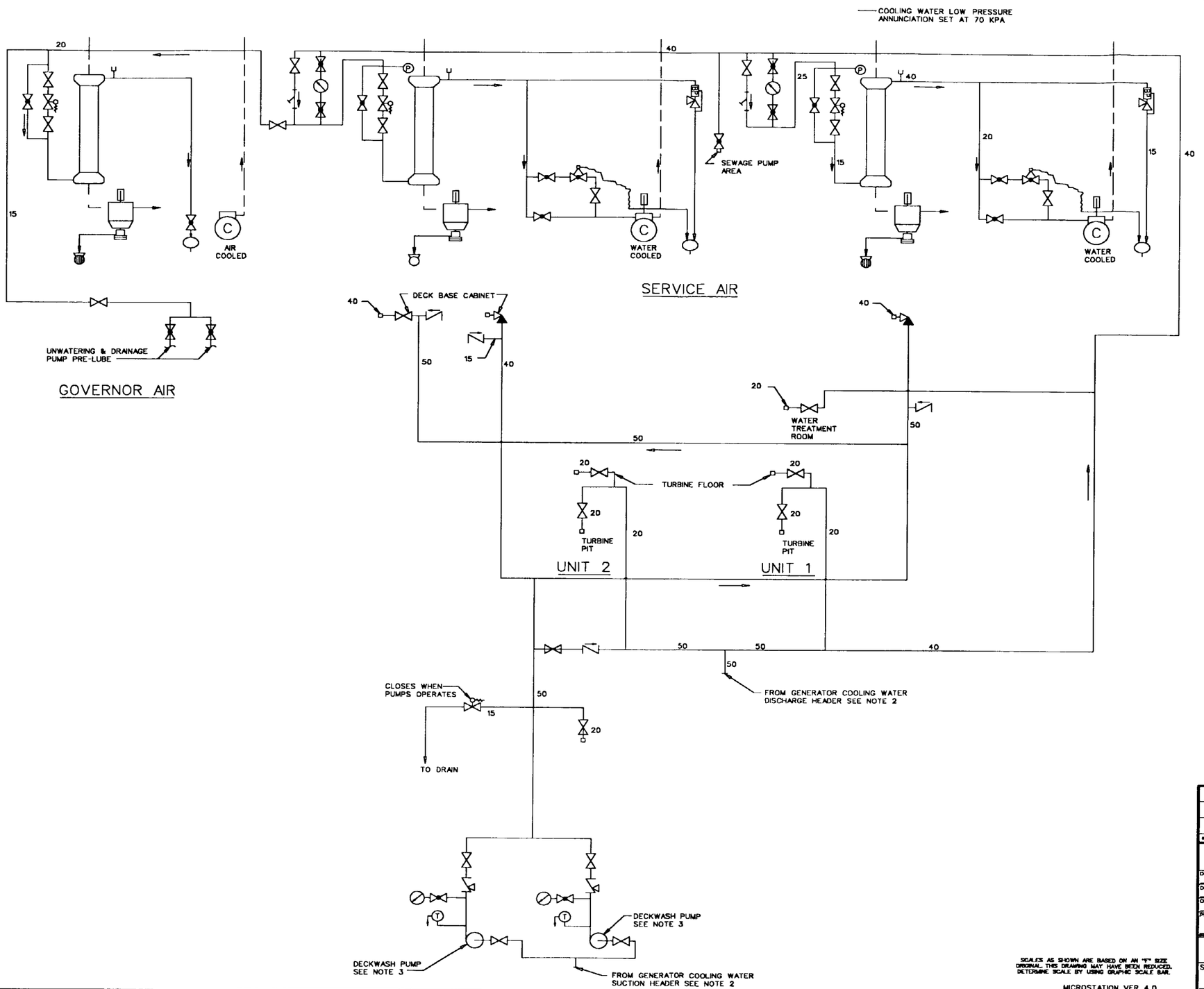
SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.

SCALES AS SHOWN ARE BASED ON AN "E" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

4 3 2 1



SYMBOLS	
	GATE VALVE
	CHECK VALVE, SWING
	CHECK VALVE, LIFT
	BALL VALVE W/ UNIVERSAL AIR HOSE CONNECTION
	THERMOMETER
	SOLENIOD CONTROLLED VALVE
	THERMOSTATIC CONTROLLED VALVE
	Y-TYPE STRAINER
	TEMPERATURE RELIEF VALVE
	BACK PRESSURE VALVE
	THERMOMETER WELL
	GLOBE VALVE
	OPEN HUB
	MOISTURE SEPARATOR
	CONDENSATE TRAP
	AFTER COOLER
C	AIR COMPRESSOR
	AIR LINE
	FLOOR DRAIN W/FUNNEL
	ANGLE VALVE W/ HOSE CONNECTION

NOTES:
1. SYSTEM SHOWN IS TYPICAL OF A 2-UNIT PLANT
2. FOR GENERATOR COOLING WATER SYSTEM SEE PAGE A-2
3. DECKWASH PUMPS PROVIDE HIGHER PRESSURE FOR DECK WASHING AND BACK-UP FIRE PROTECTION, AND SERVE AS BACK-UP FOR RAW WATER LOW PRESSURE REQUIREMENTS.
4. UNSHADED VALVES - NORMALLY OPEN, SHADED VALVES NORMALLY CLOSED.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

REVISION	DATE	DESCRIPTION	APPROVED

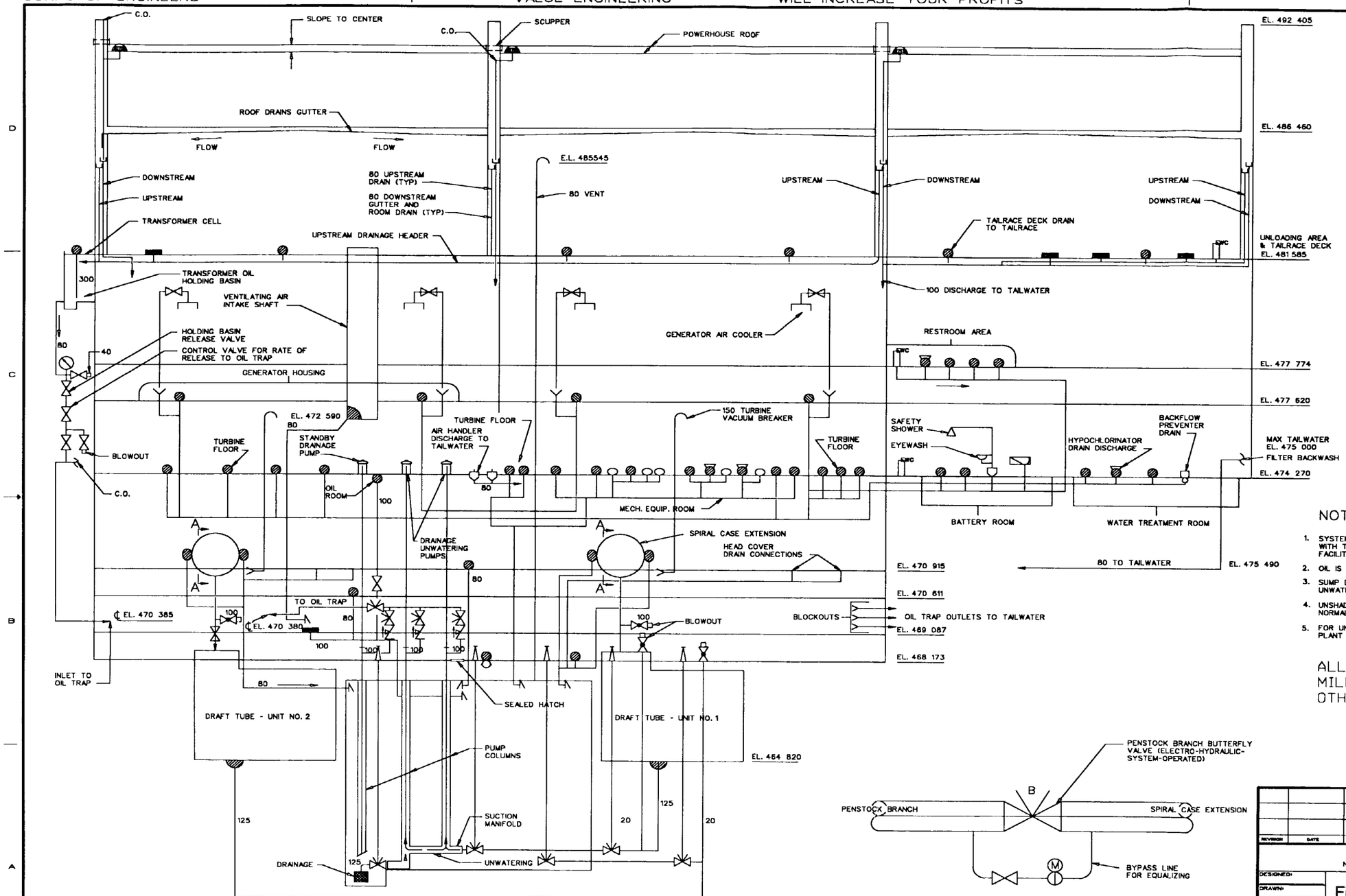
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-9. (Concluded)

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.



UNWATERING AND DRAINAGE
NO SCALE

SYMBOLS	
	FLOOR DRAIN
	ROOF DRAIN
	GUTTER DRAIN
	FLOOR DRAIN WITH FUNNEL
	SPRIAL CASE HOUSING DRAIN
	GATE VALVE
	CHECK VALVE LIFT
	BUTTERFLY VALVE
	BALL VALVE
	GATE VALVE W/ HOSE CONNECTION
	BACKWATER VALVE
	SIGHT FUNNEL
	VERITCAL BALL VALVE
	SCUPPER
	SEALED DRAIN CONNECTION
	GUTTER OUTLET
	OPEN HUB
EWC	ELECTRIC WATER COOLER
	BATTERY ROOM SINK
	PUMP
	PRESSURE GAGE
	MOTORIZED PLUG VALVE
	DIRECTION FLOW
C.O.	CLEANOUT

NOTES:

1. SYSTEM SHOWN IS TYPICAL OF A 2-UNIT (FRANCIS PLANT) WITH TRANSFORMER OIL HOLDING BASIN, OIL TRAP FACILITY AND COMBINED UNWATERING-DRAINAGE SUMP.
2. OIL IS PUMPED FROM OIL TRAP WITH PORTABLE PUMP.
3. SUMP DRAIN SUCTION LINE NORMALLY CLOSED DURING UNWATERING.
4. UNSHADED VALVES-NORMALLY OPEN, SHADED VALVES-NORMALLY CLOSED.
5. FOR UNWATERING SYSTEM IN TYPICAL 8 UNIT KAPLAN PLANT SEE PAGE A-10.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

VIEW A-A
TYPICAL BOTH PENSTOCKS

REVISION	DATE	DESCRIPTION	CHIEF BRANCH / CHIEF BRANCH / CHIEF BRANCH APPROVED

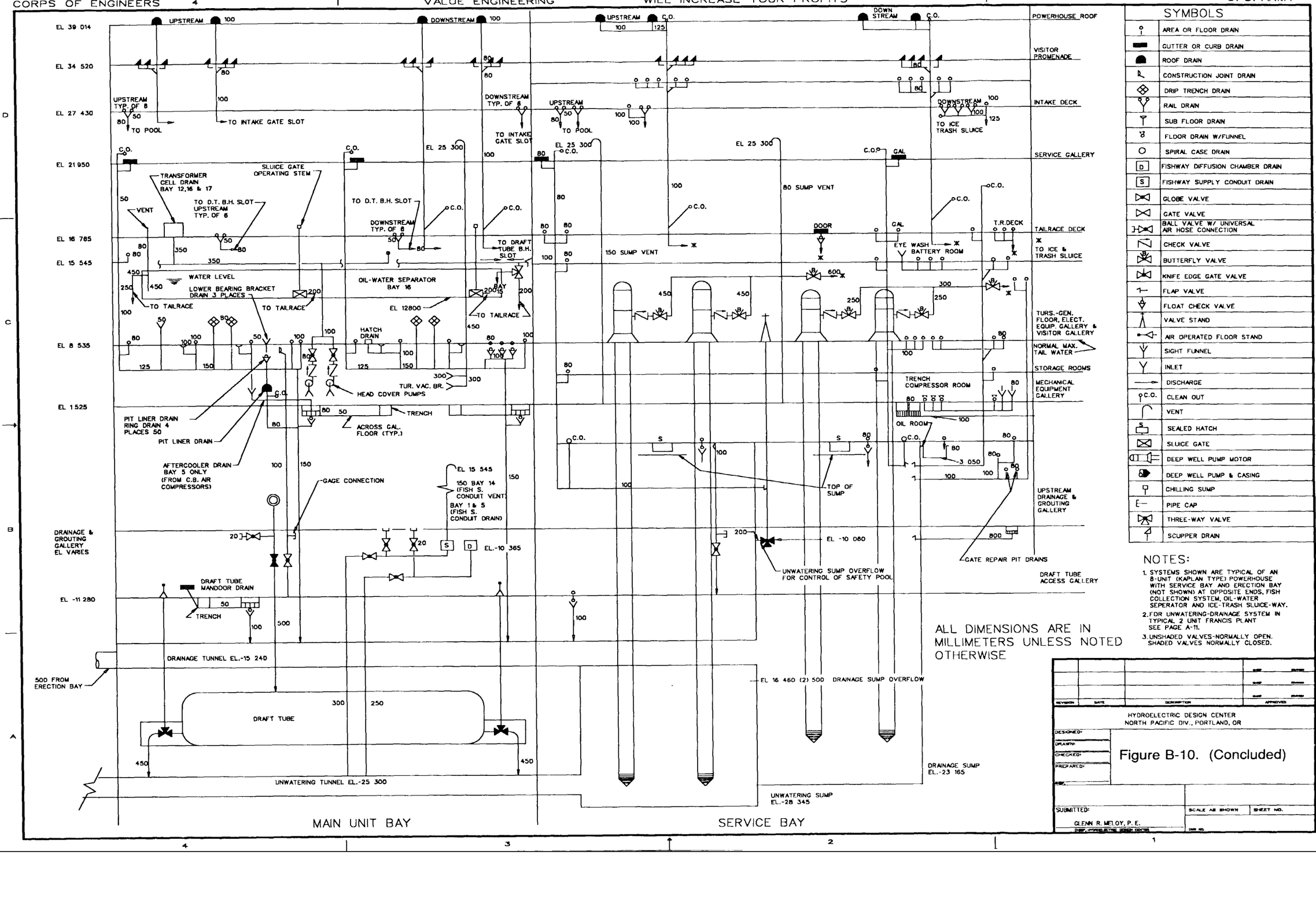
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:
APPR.

Figure B-10. Unwatering - drainage system (Continued)

SUBMITTED:
GLENN R. MELOY, P.E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.



SYMBOLS

	AREA OR FLOOR DRAIN
	GUTTER OR CURB DRAIN
	ROOF DRAIN
	CONSTRUCTION JOINT DRAIN
	DRIP TRENCH DRAIN
	RAIL DRAIN
	SUB FLOOR DRAIN
	FLOOR DRAIN W/FUNNEL
	SPIRAL CASE DRAIN
D	FISHWAY DIFFUSION CHAMBER DRAIN
S	FISHWAY SUPPLY CONDUIT DRAIN
	GLOBE VALVE
	GATE VALVE
	BALL VALVE W/ UNIVERSAL AIR HOSE CONNECTION
	CHECK VALVE
	BUTTERFLY VALVE
	KNIFE EDGE GATE VALVE
	FLAP VALVE
	FLOAT CHECK VALVE
	VALVE STAND
	AIR OPERATED FLOOR STAND
	SIGHT FUNNEL
	INLET
	DISCHARGE
C.O.	CLEAN OUT
	VENT
S	SEALED HATCH
	SLUICE GATE
	DEEP WELL PUMP MOTOR
	DEEP WELL PUMP & CASING
	CHILLING SUMP
	PIPE CAP
	THREE-WAY VALVE
	SCUPPER DRAIN

NOTES:

1. SYSTEMS SHOWN ARE TYPICAL OF AN 8-UNIT (KAPLAN TYPE) POWERHOUSE WITH SERVICE BAY AND ERECTION BAY (NOT SHOWN) AT OPPOSITE ENDS, FISH COLLECTION SYSTEM, OIL-WATER SEPERATOR AND ICE-TRASH SLUICE-WAY.
2. FOR UNWATERING-DRAINAGE SYSTEM IN TYPICAL 2 UNIT FRANCIS PLANT SEE PAGE A-11.
3. UNSHADED VALVES-NORMALLY OPEN. SHADED VALVES NORMALLY CLOSED.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

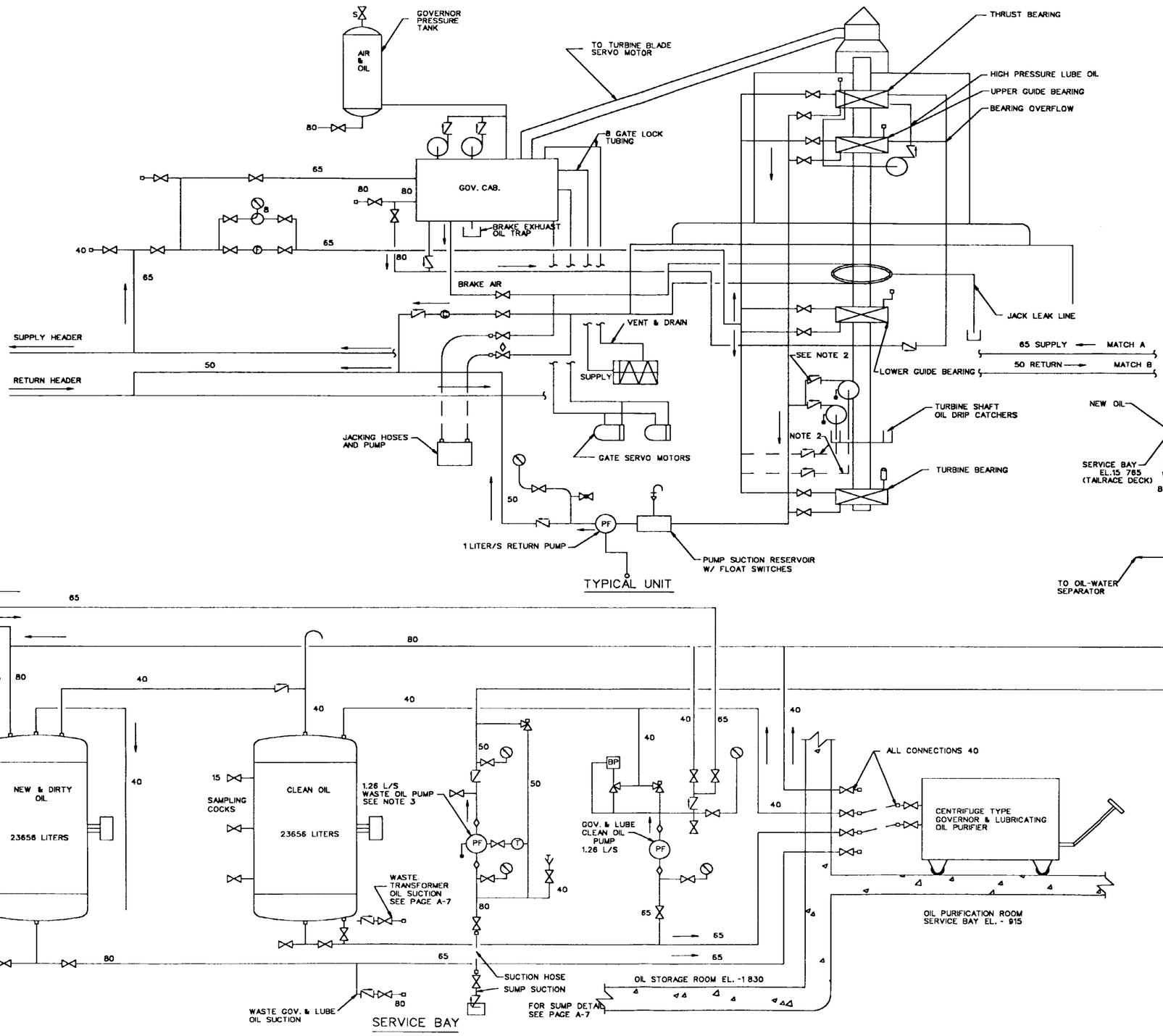
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-10. (Concluded)

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.



SYMBOLS

	GLOBE VALVE
	GATE VALVE
	NEEDLE VALVE
	BALL VALVE
	CHECK VALVE
	HOSE ADAPTER
	ANGLE VALVE
	PRESSURE GAGE
F	FILTER
G	CYLLINDER (SIGHT) GLASS
	HOSE W/ FEMALE SWIVEL
	OIL LEVEL INDICATOR
	SAFTY VALVE
	LOW LEVEL ALARM
T	ELECTRIC THERMOSTAT
	ANGLE RELIEF VALVE
	AIR & VACUUM FLOAT VALVE
BP	BACKPRESSURE VALVE
	LIQUID LEVEL GAGE
	CONTAINER
	3-WAY, 2-PORT PLUG VALVE
	UNION
	PUMP PRIMER
PF	FIXED DISPLACEMENT PUMP
PF	FIXED DISPLACEMENT PUMP W/FLOAT VALVE
	3-WAY VALVE

NOTES:

1. SYSTEM SHOWN IS TYPICAL OF AN 8-UNIT (KAPLAN) PLANT WITH SEPARATE OIL STORAGE AND PURIFIER ROOMS, OIL DELIVERY BY TANK TRUCK AND A POWERHOUSE OIL-WATER SEPARATOR FACILITY FOR SPILLAGE.
2. WASTE OIL PUMP HANDLES GOVERNOR-LUBE OIL AND TRANSFORMERFOIL.
3. USE GRAVITY RETURN FROM UNIT TO STORAGE ROOM WHEN TURBINE CONFIGURATION PERMITS.
4. UNSHADED VALVES - NORNALLY OPEN, SHADED VALVES NORMALLY CLOSED.
5. FOR TRANSFORMEER OIL SYSTEM SEE PAGE A-7.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

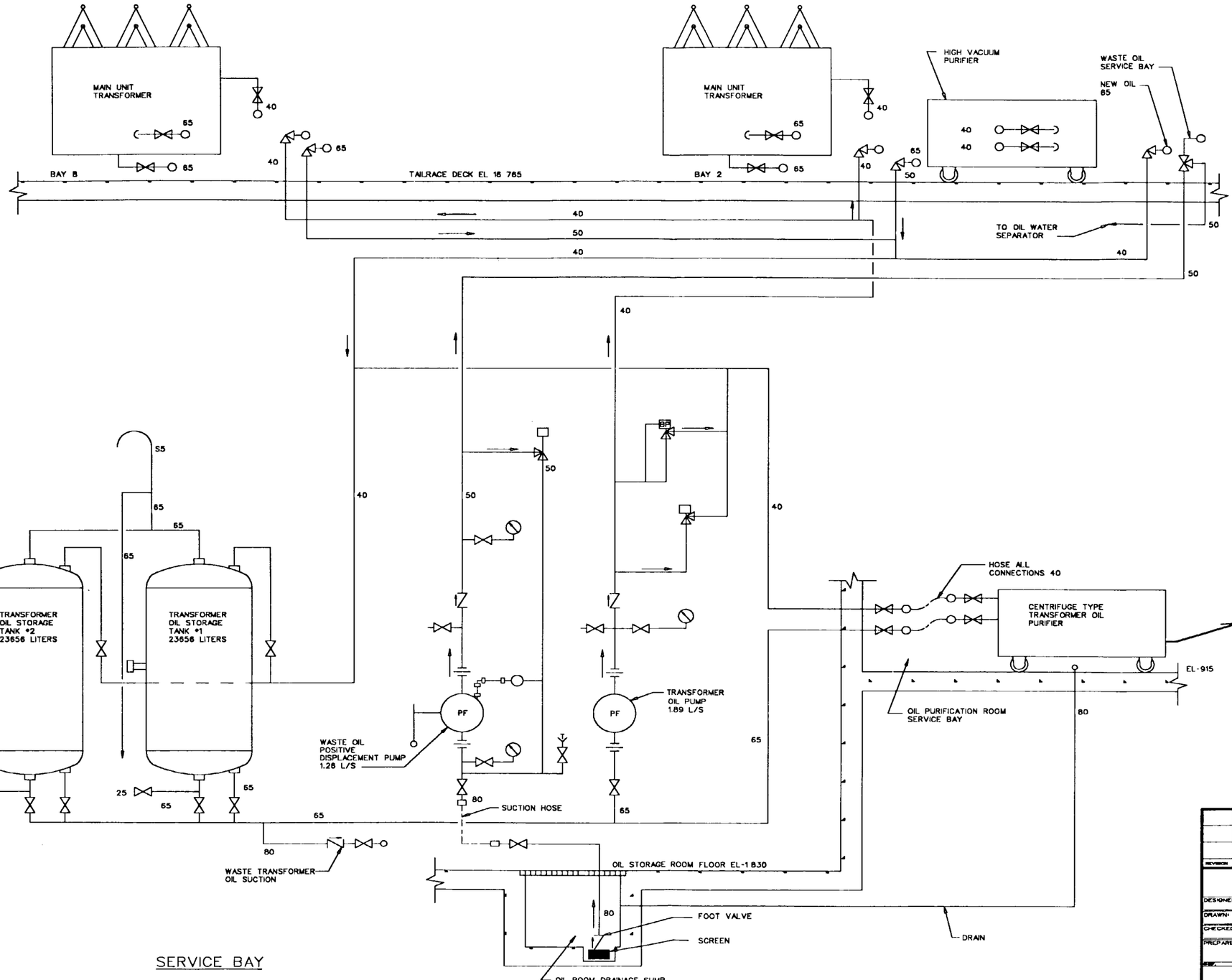
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-11. Governor - lubricating oil system

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.



SYMBOLS	
	GATE VALVE
	HOSE ADAPTER W/ CAP & CHAIN
	ANGLE VALVE
	FLOOR DRAIN
	ANGLE RELIEF VALVE
BP	BACK PRESSURE VALVE
	PRESSURE GAGE
	ELECTRIC THERMOSTAT
	LIQUID LEVEL GAGE
	VENT
	GLOBE VALVE
	CHECK VALVE
PF	FIXED DISPLACEMENT PUMP
PF	FIXED DISPLACEMENT PUMP WITH FLOAT CONTROL
	PUMP PRIMER
	3-WAY VALVE

NOTES:

1 SYSTEM SHOWN IS TYPICAL OF AN 8-UNIT (CAPLAN) PLANT WITH SEPARATE OIL STORAGE AND PURIFIER ROOMS, OIL DELIVERY BY TANK TRUCK AND A POWERHOUSE OIL-WATER SEPARATOR FACILITY FOR SPILLAGE.

2 WASTE OIL PUMP HANDLES GOVERNOR-LUBE OIL AND TRANSFORMER OIL.

3. UNSHADED VALVES-NORMALLY OPEN, SHADED VALVES-NORMALLY CLOSED.

4. GOVERNOR LUBE OIL SYSTEM LOCATED ON PAGE A-6.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-12. Transformer oil system

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.

PIPING MATERIAL SCHEDULE

	GROUP	SYSTEM	MAX. PRESS KPA	PIPE	FITTINGS	VALVES SEE NOTES 15 & 17	
WATER DRAINS AND VENTS	A	GENERATOR COOLING (10) SERVICE RAW WATER SPIRAL CASE DRAIN SPIRAL CASE FILL DRAFT TUBE DRAIN UNWATERING AND DRAINAGE PUMP DISCHARGE TURBINE GLANDS WATER SPRAY FIRE PROTECTION (UPSTREAM OF DELUGE VALVE) TURBINE AIR SUPPLY	865	LESS THAN 80: SEAMLESS COPPER TUBING TYPE K SOLDER JOINT. ASTM B88M 80 AND LARGER: SEAMLESS BLACK STEEL, ASTM A53. SCHEDULE OR THICKNESS: SEE NOTE 7 SIZES THRU 250 SCH. 40 SIZES 300 AND LARGER 10 THICK WALL.	LESS THAN 80: FOR COPPER TUBING, WROUGHT COPPER, SOLDER JOINT ANSI STD. B-16.22 OR CAST BRASS SOLDER-JOINT ANSI STD. B-16.18 WATER HOSE THREADS: ASME B1.20.7 80 AND LARGER: BUTT WELDING, STEEL, BLACK, ANSI STD. B-16-9 THICKNESS SAME AS PIPE. SEE NOTE 12 FLANGES: 1040 KPA FORGED STEEL, WELDING, FLAT FACED WHEN ADJACENT TO CAST IRON VALVES AND FITTINGS. SEE NOTE 10. MSS SP-44 CAST IRON: FLANGED ASTM A126	LESS THAN 80: BRONZE, SOLDER JOINT IN COPPER LINES, THREADED IN BRASS. GATE, GLOBE, ANGLE, AND CHECK. MSS SP-80. BALL VALVES: MSS SP-72	80 AND LARGER IN STEEL LINES: GATE VALVES: IRON-BODY, OS&Y, FLANGED, MSS SP-70 GLOBE AND ANGLE VALVES: IRON BODY BRONZE MOUNTED, OS&Y WITH RENEWABLE DISC AND SEAT RING, 865 KPA STEAM RATING. MSS SP-85. BUTTERFLY VALVES: SEE NOTE 1 & 20. MSS SP-67. LIFT CHECK: NON-SLAM TYPE, CAST IRON BODY, FLANGED FOR 865 KPA SERVICE, FACED AND DRILLED IN ACCORDANCE WITH ASA REQUIREMENTS. STAINLESS STEEL TRIM WITH STAINLESS STEEL HELICAL SPRING. DISC SHALL BE GUIDED WITH TWO-POINT BEARING, ALL WEARING PARTS SHALL BE REPLACABLE. BALL VALVES: MSS SP-72 FLANGED, FULL BORE.
	B	POTABLE WATER	865	LESS THAN 80: SAME AS GROUP A 80 AND LARGER: GALV. STEEL, WELDED JOINT ASTM A-53 TYPE E SCH. 40 SEE NOTE 5	SAME AS GROUP A EXCEPT 80 AND LARGER PIPE IS GALVANIZED. SEE NOTE 5	SAME AS GROUP A	
	C	WATER SPRAY FIRE PROTECTION (DOWNSTREAM OF DELUGE VALVE)	1040	GALVANIZED STEEL ASTM A-53 TYPE E SCH. 40 LESS THAN 80 THREADED 80 AND LARGER WELDED, SEE NOTE 5	LESS THAN 65: GALVANIZED MALLEABLE-IRON, THREADED, ANSI B16.3 AND MSS SP-83, B16.39 80 AND LARGER: SAME AS GROUP A EXCEPT GALVANIZED, SEE NOTE 5	SAME AS GROUP A	
	D	AIR CONDITIONING CIRCULATING WATER SEE NOTE 8	125	STEEL ASTM A-53 TYPE E LESS THAN 65 GALV. THREADED 65 AND LARGER, BLACK, WELDED.	LESS THAN 65: SAME AS GROUP C, LESS THAN 80. 65 AND LARGER: SAME AS GROUP A, 80 AND LARGER	SAME AS GROUP A	
	E	BUILDING AND ROOF DRAINS SANITARY DRAINS AND VENTS WATER DISCHARGES EMBEDDED.		EXPOSED: SEAMLESS STEEL, ASTM A53 BURIED AND EMBEDDED: HUBLESS CAST IRON, CISPI 301.	EXPOSED: SCREWED CAST IRON DRAINAGE, GALVANIZED ASTM A888 BURIED AND EMBEDDED: SAME AS PIPE SEE NOTES 3 AND 13	NONE	
	F	TURBINE VACUUM BREAKER AND SUMP VENTS		BLACK STEEL, WELDED JOINT, ASTM A53 B THICK WALL, SEE NOTE 7	SAME AS GROUP A, 80 AND LARGER.	NONE	
	G	BATTERY ROOM DRAINS		EXPOSED: PVC U.S. DEPT. OF COMMERCE STD. CS 207, SCH. 80 OR ACID-RESISTING "DURIRON" OR "CORROSIRON" OR EQUAL. EMBEDDED: "DURIRON" OR "CORROSIRON" OR EQAUL.	SAME AS TYPE AND MANUFACTURER AS PIPE	NONE	
	H	PRESSURE SEWAGE	700	EXPOSED: BLACK STEEL, WELDED JOINT, SCH. 80, ASTM A-53. BURIED OR EMBEDDED: DUCTILE IRON, ASTM A377.	EXPOSED: SAME AS GROUP A BURIED AND EMBEDDED: AWWA C110/A21.10 AND C111/A21.11	GATE: IRON-BODY, OS&Y, FLANGED, MSS SP 70-90 SWING CHECK: IRON-BODY BRASS MOUNTED WITH RENEWABLE BODY SEAT RING. 865 KPA STEAM RATING. MSS SP 71-90	BALL VALVES: MSS SP-72
	I	PIEZOMETER	865	SAME AS GROUP A, LESS THAN 80 SEE NOTE 18	SAME AS GROUP A, LESS THAN 80.	ANGLE VALVE: MSS SP-80, BRONZE, THREADED.	
OIL	K	GOVERNER & LUB OIL, CIRCUIT BREAKER AND TRANSFORMER OIL TRANSFORMER OIL TRANSFER SYSTEMS.	1040	SEAMLESS COPPER TUBING TYPE K, ASTM B88. SEE NOTE 9	SAME AS GROUP A, LESS THAN 80. OIL HOSE THREADS: ASME 31.20.7, SEE NOTE 14	GLOBE, ANGLE, AND SWING CHECK: MSS SP-80.	
AIR-GAS	M	SERVICE AIR BRAKE AIR DRAFT TUBE DEPRESSION AIR BUBBLER AIR LINES	865	SAME AS GROUP B. SEE NOTE 4	SAME AS GROUP B. UNIVERSAL HOSE COUPLING: BRONZE, NFPA T3.20.14	SAME AS GROUP A	
	O	GOVERNER AIR NITROGEN	4140	GALVANIZED STEEL, THREADED. ASTM A-106 SCH. 80	LESS THAN 65: GALVANIZED MALLEABLE-IRON, THREADED 4140 KPA W.O.G. MIN. 65 AND LARGER: FORGED STEEL 13800 KPA W.O.G.	GLOBE VALVE: BRONZE, 6900 KPA MSS SP-80	CHECK VALVE: BRONZE, SWING 6900 KPA W.O.G. MSS SP-80
	P	CO2. SEE NOTE 16					
	R	GOVERNER AIR	7590	STAINLESS TYPE 304 OR 316 SCH. 40.	STAINLESS TYPE 304 OR 316 13800 KPA SOCKET WELD	STAINLESS BALL VALVE, SOCKET WELD, REINFORCED TEFLON SEAT MSS SP-110-92	
MISC.	S	HYPOCHLORITE SOLUTION		PVC. US DEPT. OF COMMERCE STD. CS 207, SCH. 80 (NOTE 2)	SAME RATING AND MANUFACTURER AS PIPE.	PVC	
	Y	FLOATWELLS		EXPOSED: SAME AS GROUP B EMBEDDED: ASBESTOS CEMENT WITH NEOPRENE GASKETS, ASTM C428	EXPOSED: SAME AS GROUP B. EMBEDDED: SAME AS PIPE	NONE	
	Z	SLEEVES		STEEL, BLACK, ASTM A-53 SCH. 40			

NOTES:

1. 865 KPA CAST IRON FLANGES WITH RAISED FACE FLANGES OR WAFER TYPE VALVES SHOULD BE AVOIDED.
2. PVC PIPE 15 AND LARGER ONLY IS COVERED UNDER CS 207, SMALLER SIZES SHOULD BE MANUFACTURERS STANDARD.
3. GROUP A COPPER ELBOWS AND ALL GROUP E ELBOWS SHOULD BE LONG RADIUS OR LONG SWEEP.
4. USE GALVANIZED STEEL PIPE BETWEEN COMPRESSOR AND AFTERCOOLER (SAME AS GROUP C) FOR 65 AND LESS LOW PRESSURE AIR.
5. WELDED GALVANIZED PIPE SHOULD NORMALLY BE GALVANIZED AFTER FABRICATION.
6. FULL PORT BALL VALVES ARE NORMALLY AVAILABLE THROUGH SIZE 50 WHEN REQUIRED.
7. EMBEDDED LINES OPEN TO TAILWATER OR FOREBAY WITHOUT EXTERNAL PROVISIONS FOR READY SHUT-OFF SHOULD BE EXTRA HEAVY STEEL (UP TO 15 WALL) FROM THE FIRST VALVE TO A POINT BACK IN THE CONCRETE APPROX. 1525. OTHER EMBEDDED LINES SHOULD MEET THE SAME REQUIREMENTS FROM THE FIRST EXPOSED JOINT BACK INTO THE CONCRETE AT LEAST 1 X 25
8. ONCE THROUGH AIR CONDITIONING WATER SHOULD BE GROUP A.
9. FOR COPPER OIL LINES ADD SEPARATE GROUP WITH REQUIRED JOINTS WHEN TEMPERATURE OR PRESSURE EXCEED SOFT SOLDER JOINT RATING.
10. FOR GROUP A PIPING 80 AND LARGER USE SLIP-ON WELDING FLANGES OR PIPE AND WELDING NECK FLANGES OR FITTINGS.
11. USE DIELECTRIC FITTINGS BETWEEN FERROUS PIPE OR EQUIPMENT AND COPPER AIR AND WATER LINES.
12. IF SPECIFIED WALL THICKNESS IS UNAVAILABLE USE THE NEXT HEAVIER AVAILABLE. (80 AND LARGER BUT WELD FITTINGS)
13. IN DRAIN LINES USE COMBINATION "Y" AND 1/8 BENDS WHEREVER POSSIBLE FOR BRANCHES FROM HORIZONTAL RUNS.
14. HOSE THREADS SHOULD HAVE MANUFACTURERS TAG SHOWING THREAD SPECIFICATION.
15. VALVE AND FITTING SHOULD NORMALLY BE SAME AS LINE SIZE.
16. REFER TO NFPA FOR REQUIREMENTS OF CO2 PIPE AND FITTINGS.
17. USE RISING STEM VALVES UNLESS OTHERWISE INDICATED WITH PACKING AND SEAT MATERIALS SUITABLE FOR SERVICE.
18. PIEZOMETER TUBING EMBEDDED MORE THAN 150 MAY BE TYPE K ANNEALED WITH BENT TURNS.
19. PIPING LOCATION TERMINOLOGY
    BURIED: IN SOIL
    EMBEDDED: IN CONCRETE
    EXPOSED: ACCESSIBLE
20. BUTTERFLY VALVES SHOULD CONFORM TO THE APPLICABLE REQUIREMENTS OF SECTIONS 5 THRU 14 OF AWWA STANDARD C504 MODIFIED AS APPROPRIATE FOR THE PARTICULAR APPLICATION. SEATS SHOULD NORMALLY BE BURA-N OR EQUAL. BE LOCATED IN THE VALVE BODY, AND FIELD REPLACEABLE.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	CHIEF	DESIGN
			CHIEF	DRAWN
			CHIEF	APPROVED

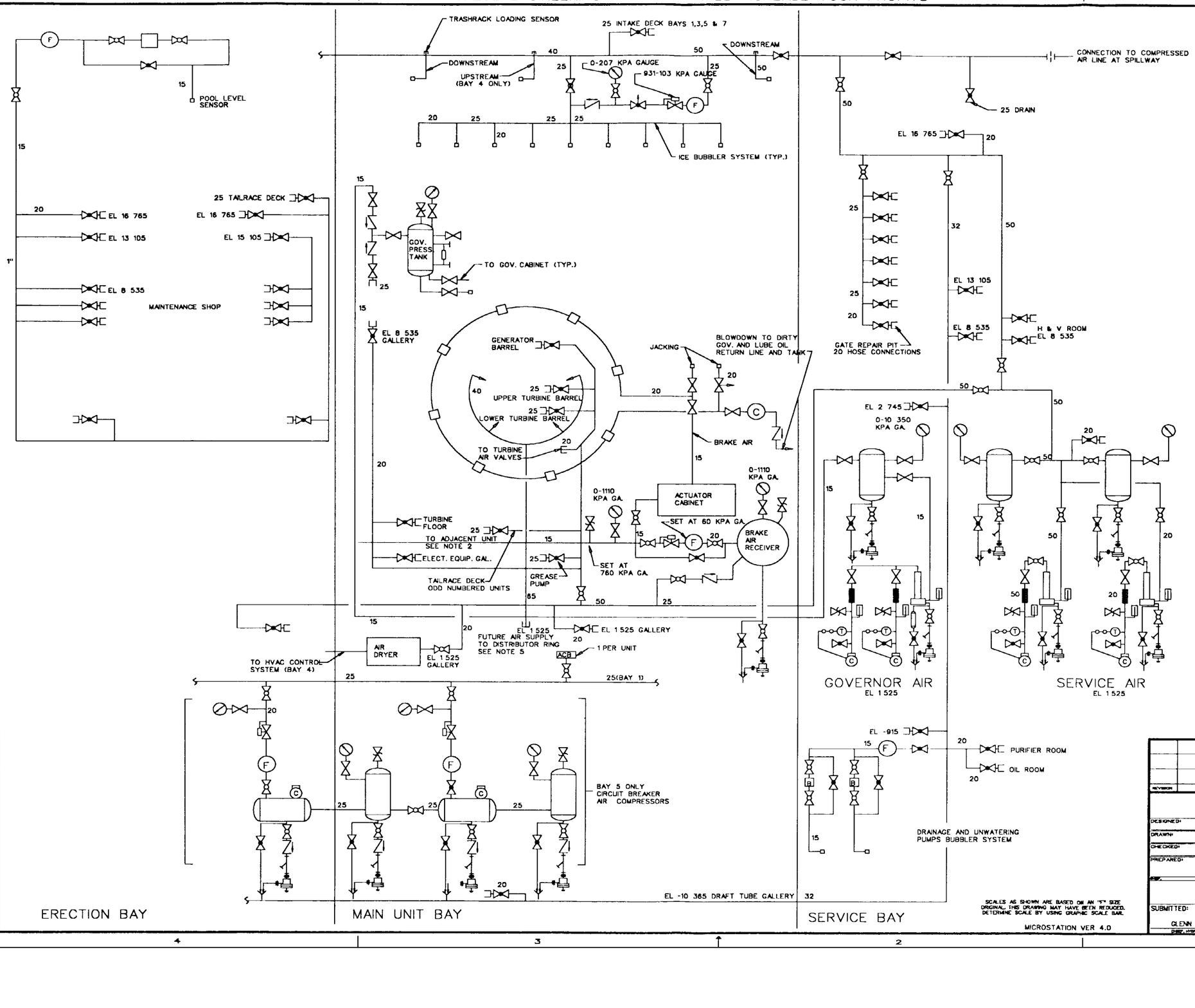
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-13. Piping material schedule

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.



SYMBOLS

	GLOBE VALVE
	GATE VALVE
	SWING CHECK VALVE
	BALL VALVE
	SAFETY VALVE
	NEEDLE VALVE
	PRESSURE REDUCING VALVE
	PRESSURE GAGE
F	AIR FILTER
C	AIR COMPRESSOR
	BUBBLER NOZZLE
ACB	AIR CIRCUIT BREAKER
	AFTERCOOLER & MOISTURE SEPARATOR
	THERMOMETER
T	ELECTRIC THERMOSTAT
	FLOW DIRECTION
	AIR RECEIVER
	INVERTED BUCKET TRAP
C	CYLINDER (SIGHT) GLASS
	SIGHT GLASS W/SHUT-OFF V.
	PIPE CAP
	OPEN HUB
	UNION
	FLEXIBLE CONNECTOR
B	BUBBLER CONTROL
	Y-TYPE STRAINER
	UNIVERSAL AIR HOSE CONN.
	HOSE ADAPTER

NOTES:

1. SYSTEMS SHOWN ARE TYPICAL OF AN 8 UNIT POWERHOUSE WITH KAPLAN UNITS. INTAKE GATES AND TRASH RACKS. GATE REPAIR PIT AND WITH SPILLWAY AIR CAPACITY AVAILABLE FOR ICE BUBBLERS AND MAJOR MAINTENANCE.
2. ONE BRAKE AIR SYSTEM FOR EACH PAIR OF UNITS.
3. SERVICE AIR-NOMINAL 690 KPA GOVERNOR AIR-NOMINAL 6900 PSI.
4. UNSHADED VALVES-NORMALLY OPEN, SHADED VALVES-NORMALLY CLOSED.
5. MINIMUM PROVISIONS FOR FUTURE AIR SUPPLY TO DISTRIBUTOR RING IS NECESSARY FOR ALL UNITS.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

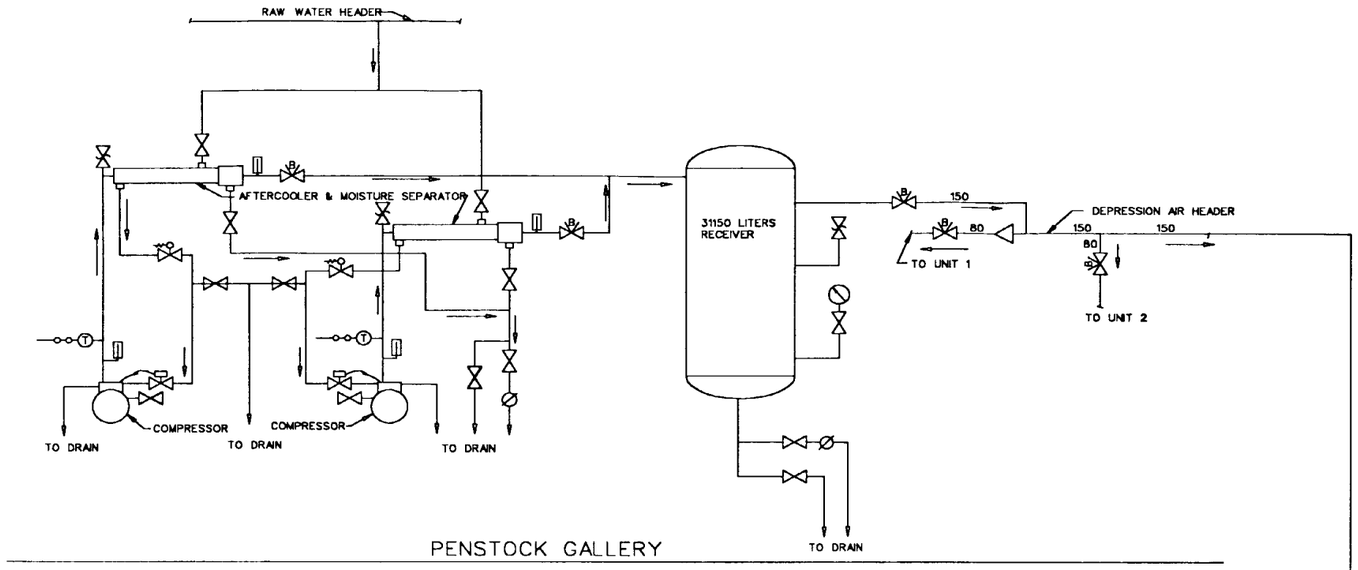
Figure B-14. Compressed air system

SUBMITTED:
GLENN R. MELOY, P.E.
CHIEF, HYDROELECTRIC DESIGN CENTER

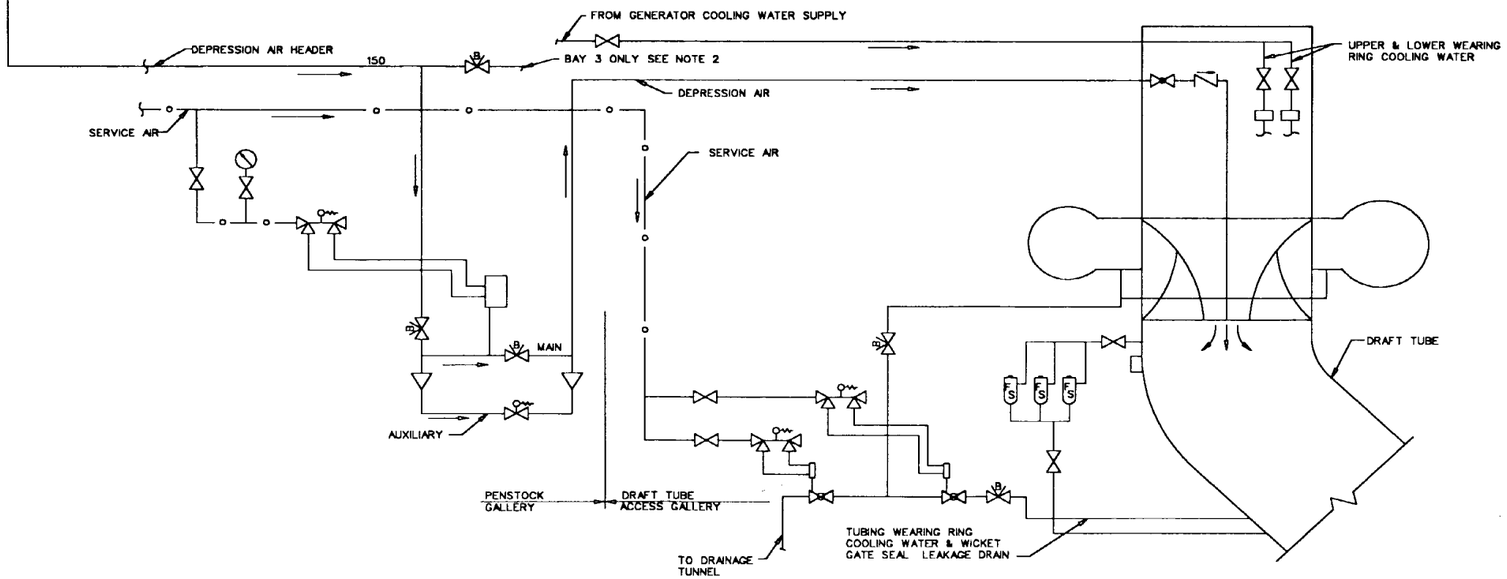
SCALE AS SHOWN | SHEET NO.

SCALES AS SHOWN ARE BASED ON AN "E" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0



SYMBOLS	
— o —	SERVICE AIR
------	INDUSTRIAL WATER
------	PIPING FURNISHED BY GOV.
	GLOBE VALVE PART. OPEN
	GATE VALVE
	BUTTERFLY VALVE
	SOLENOID VALVE
	SAFETY VALVE
	BALL VALVE CYL. OPERATED
	2-WAY 4-PORT SOLENOID VALVE
	FLOAT SWITCH
	FLOW SWITCH
	THERMOSTAT
	CONDENSATE TRAP
	THERMOSTAT CONTROLLED
	CYLINDER OPERATOR



UNIT 3
TYPICAL FOR ALL UNITS

NOTES:
1. SYSTEM SHOWN IS TYPICAL OF A SIX UNIT FRANCIS PLANT WITH 2-90 MW UNITS AND 4-220 MW UNITS WITH ALL UNITS EQUIPPED FOR DRAFT TUBE WATER DEPRESSION.
2. INITIAL CONSTRUCTION PROVIDES 2-90 MW AND 1-220 MW. DEPRESSION AIR HEADER TO BE EXTENDED FOR FINAL 3 UNITS.
3. UNSHADED VALVES-NORMALLY OPEN, SHADED VALVES NORMALLY CLOSED.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

SCALES AS SHOWN ARE BASED ON AN "E" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

REVISION	DATE	DESCRIPTION	CHIEF	BRANCH
			CHIEF	BRANCH
			CHIEF	BRANCH

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

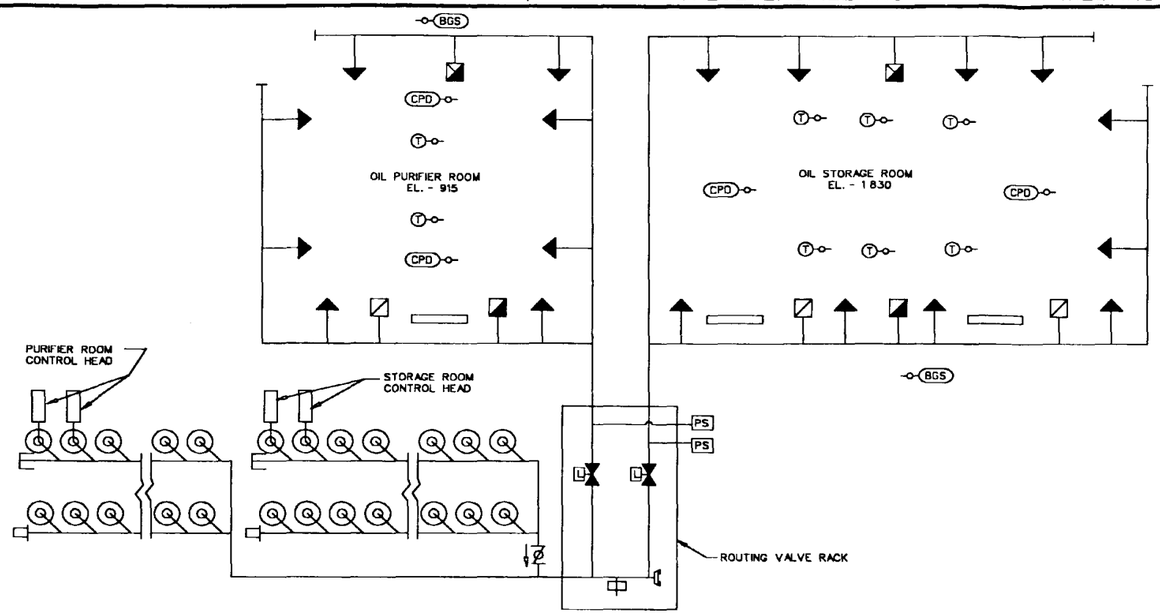
DESIGNED:
DRAWN:
CHECKED:
PREPARED:
CHIEF

Figure B-15. Draft tube water depression system

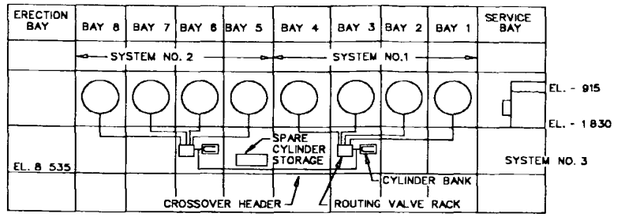
SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.

4 3 2 1



OIL STORAGE AND PURIFIER ROOMS
SYSTEM NO. 3



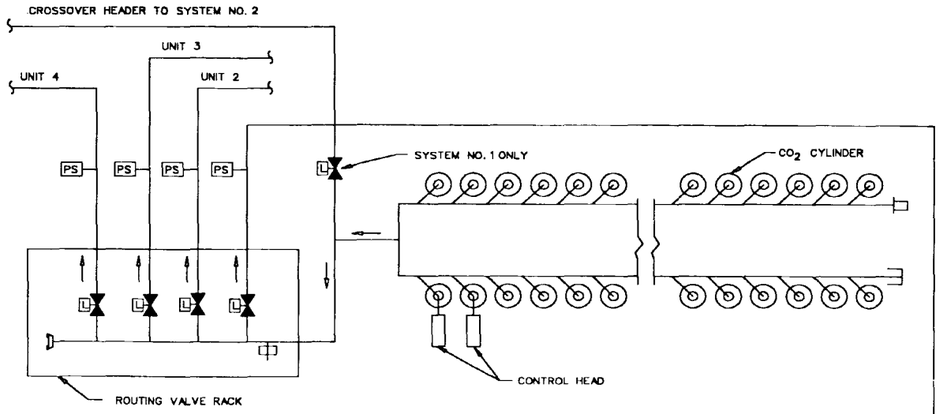
KEY PLAN
CO_2 SYSTEM LOCATIONS

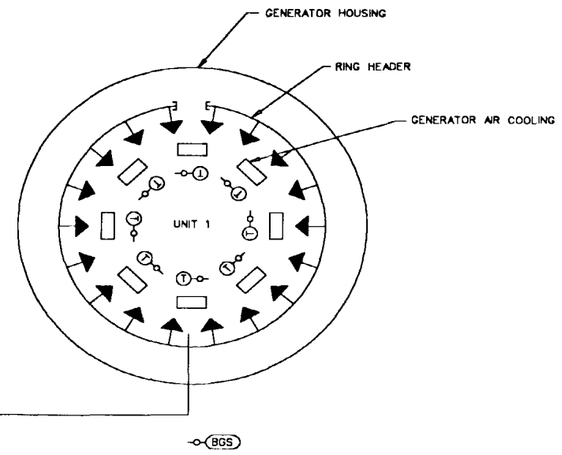
SYMBOLS	
PS	PRESSURE SWITCH
T	THERMOSTAT ELECTRIC
	CO_2 DISCARGE NOZZLE
	FIRE DOOR TRIP
	AIR SUPPLY DAMPER TRIP
	AIR EXHUAST DAMPER TRIP
L	ROUTING VALVE WITH LOCKING DEVICE
	HEADER SAFETY RELEASE DEVICE
	CO_2 PRESSURE BLEEDER
	GATE VALVE
	FIRE DOOR
	DISCHARGE INDICATOR
	PIPE CAP
CPD	COMBUSTION PRODUCTS DECTECTOR
	BALL CHECK VALVE
BGS	BREAK GLASS STATION

NOTES:

1. SYSTEM SHOWN IS TYPICAL OF AN 8 -UNIT PLANT WITH PROJECT FACILITY FOR STORAGE OF PAINT AND FLAMMABLE LIQUIDS OUTSIDE POWERHOUSE
2. COMBUSTION PRODUCTS DETECTORS CONNECTED TO ANNUNCIATION SYSTEM ONLY

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE





GENERATOR CO_2 SYSTEM NO. 1
(SYSTEM NO. 2 SIMILAR)

REVISION	DATE	DESCRIPTION	APPROVED

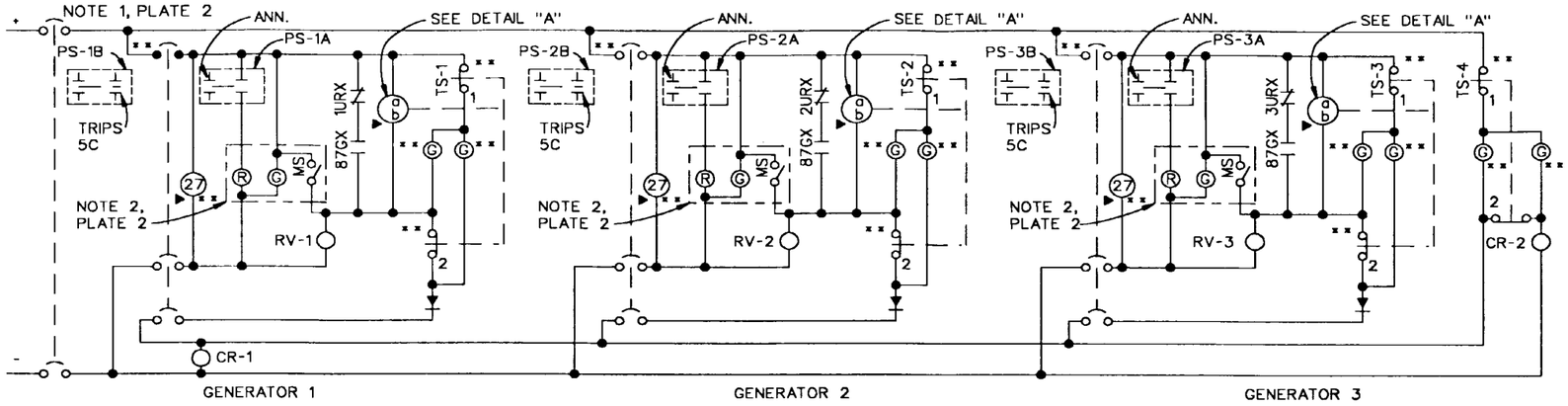
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

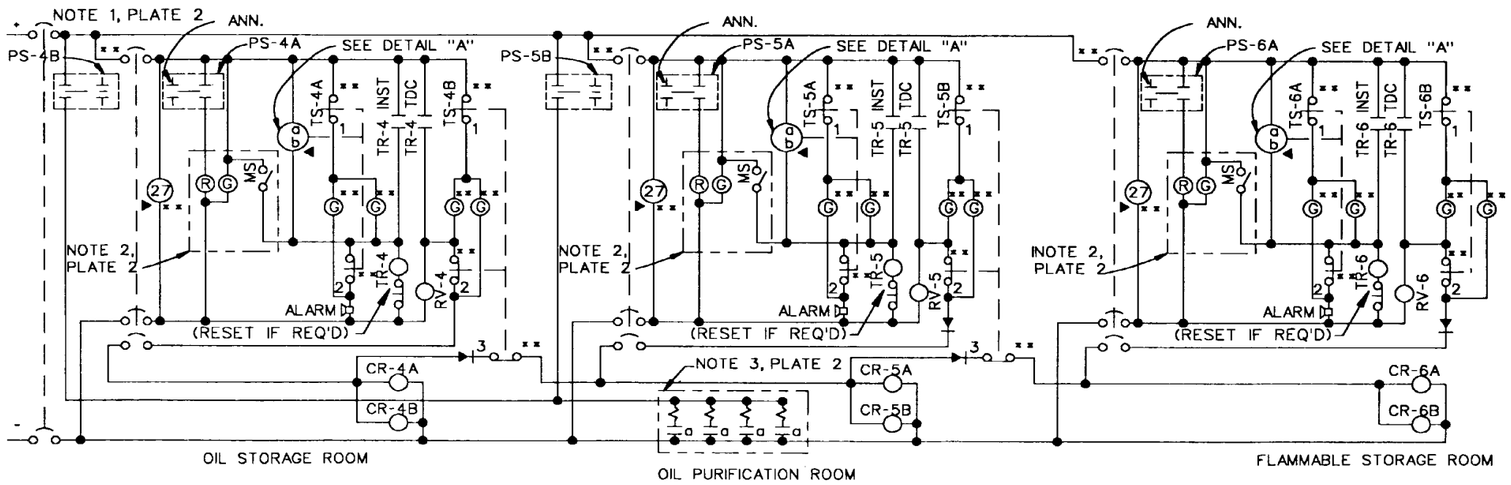
Figure B-16. Carbon dioxide fire protection system (Sheet 1 of 3)

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO. | DWG NO.

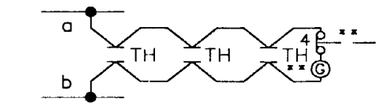


GENERATOR PROTECTION CONTROL SYSTEM (TYPICAL)



ROOM PROTECTION CONTROL SYSTEM (TYPICAL)

(ALTERNATE 1)



DETAIL "A"

SYMBOLS

CR	CYLINDER RELEASE
PS	PRESSURE SWITCH
TH	THERMOSTAT
TS	CIRCUIT CONTINUITY TEST SWITCH
TDC	TIME DELAY CLOSE
ANN	ANNUCIATOR CONTACT
5C	COMPLETE SHUTDOWN RELAY
	TIMING RELAY RESET-TEST SWITCH
	CONTACT
	BLOCKING DIODE
⊠PS	PRESSURE SWITCH
	DISCHARGE NOZZLE
	ALARM BELL
Ⓡ	RED INDICATING LIGHT
Ⓖ	GREEN INDICATING LIGHT
	INDICATES SEVERAL CONTACTS IN PARALLEL
MS	MANUAL SWITCH IN EMERGENCY BREAKGLASS STATION
RV	ROUTING VALVE RELEASE
TR	TIMING RELAY
URX	UNIT RUN AUXILIARY RELAY
(27)	UNDER VOLTAGE RELAY
87GX	GENERATOR DIFFERENTIAL AUXILIARY RELAY
**	LOCATED IN CO_2 CONTROL CABINET
	SHUNT TRIP
	2 POLE CIRCUIT BREAKER
RV	ROUTING VALVE (AUTOMATIC OPENING)
	CHECK VALVE
	PRESSURE OPERATED RELEASE (TRIP)
	LEVER OPERATED PLUG VALVE

REVISION	DATE	DESCRIPTION	APPROVED

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-16. (Sheet 2 of 3)

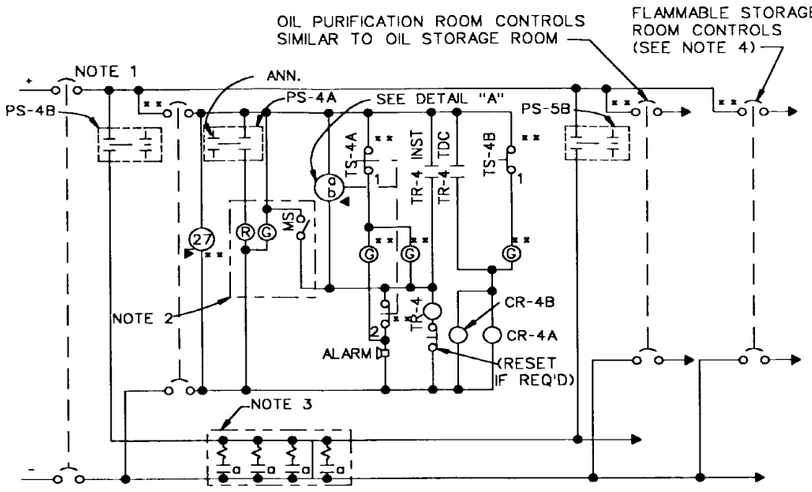
SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.

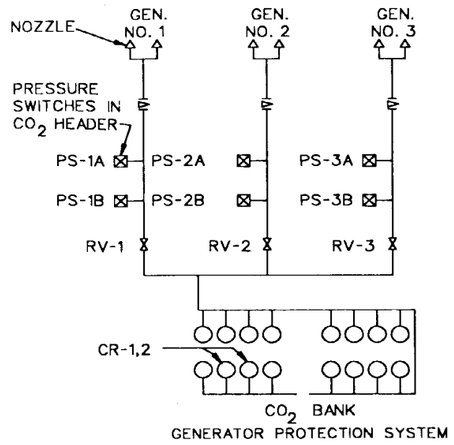
DWG NO.

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0



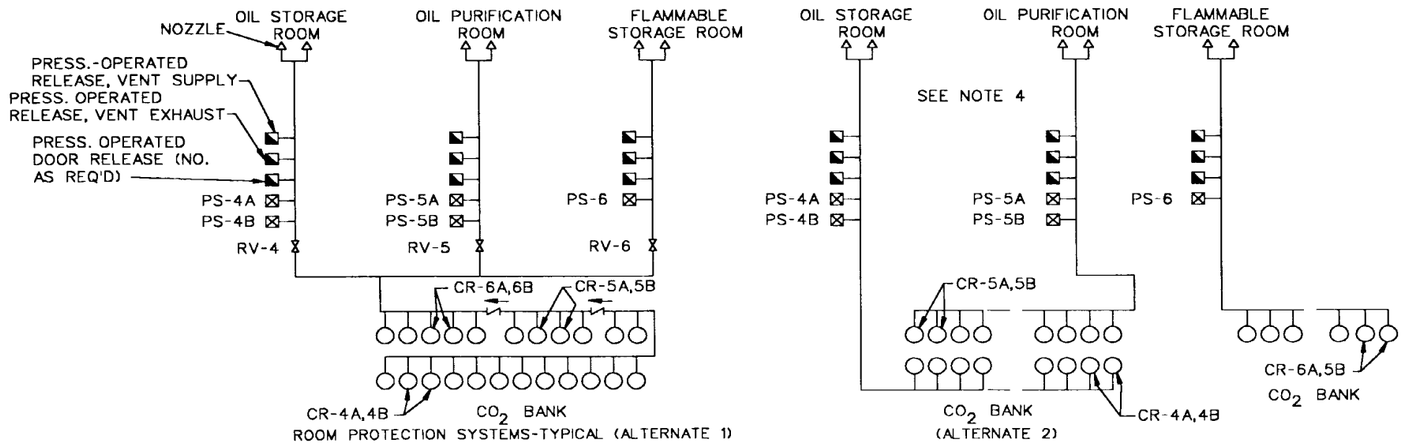
ROOM PROTECTION CONTROL SYSTEM (TYPICAL)
(ALTERNATE 2)



GENERATOR PROTECTION SYSTEM

TYPICAL TEST SWITCH
(SPRING RETURN TO NORMAL)

CONTACT	NORMAL	TEST
1		X
2	X	
3	X	
4		X



ROOM PROTECTION SYSTEMS-TYPICAL (ALTERNATE 1)

(ALTERNATE 2)

CO_2 PIPING SCHEMATICS

NOTES:

1. LOCATED ON MAIN D-C SWITCHBOARD
2. EMERGENCY BREAK-GLASS STATIONS LOCATED ON UNIT ACTUATOR OR GENERATOR HOUSING FOR GENERATORS, AND OUTSIDE DOORS TO OIL STORAGE, PURIFICATION AND FLAMMABLE STORAGE ROOMS.
3. SHUNT TRIPS FOR OIL PURIFIER, GENERATOR, LUBE OIL AND INSULATING OIL PUMP BREAKERS.
4. FLAMMABLE STORAGE ROOM CONTROLS SIMILAR TO OIL STORAGE AND OIL PURIFICATION ROOMS, EXCEPT PRESSURE OPERATED SWITCH NOT REQUIRED FOR SHUNT TRIPS.

REVISION	DATE	DESCRIPTION	DSIF APPROVED

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

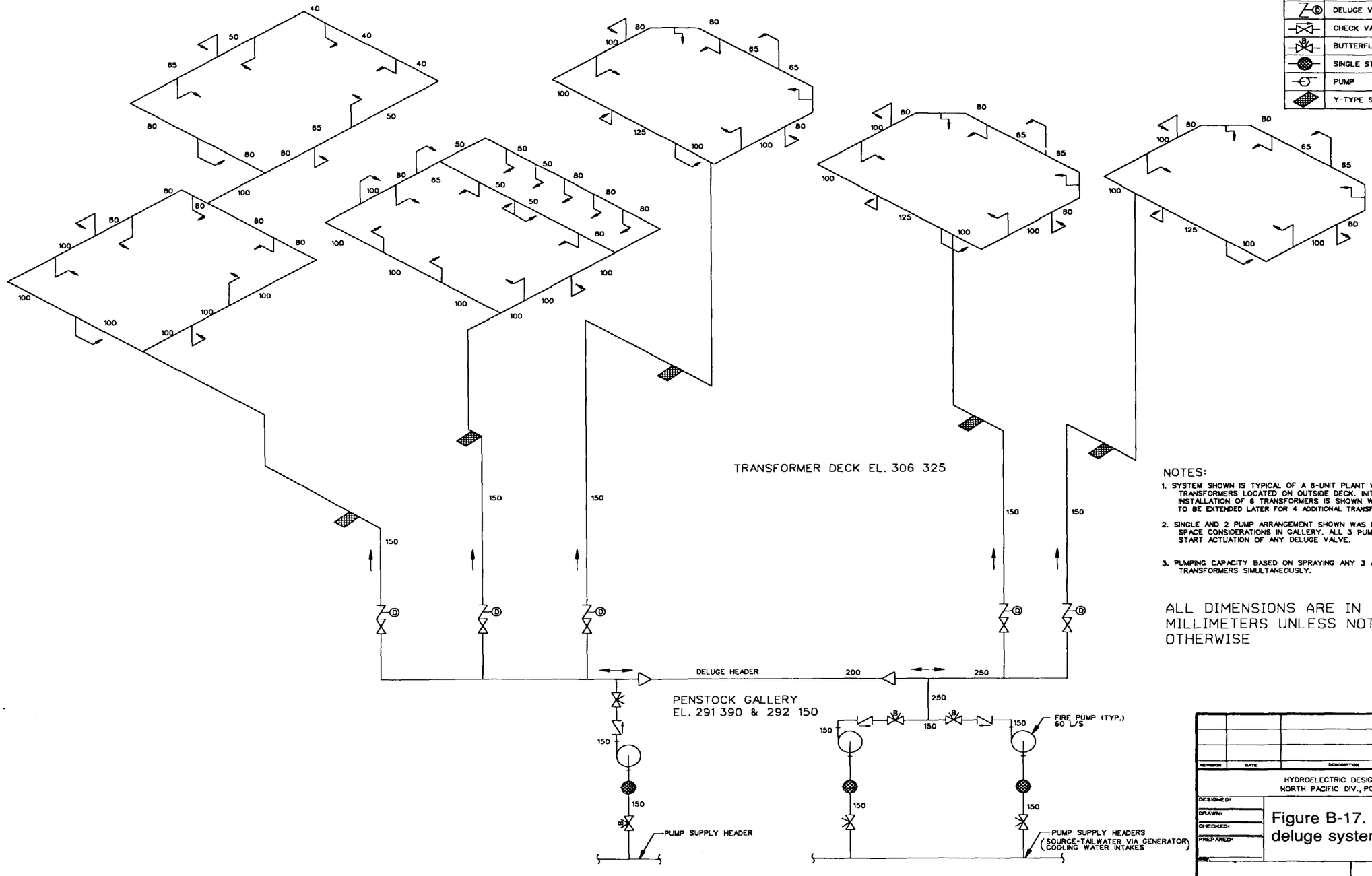
DESIGNED
DRAWN
CHECKED
PREPARED
SUPV.

Figure B-16. (Sheet 3 of 3)

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.

SYMBOLS	
	SPRAY NOZZLE
	GATE VALVE
D	DELUGE VALVE
	CHECK VALVE
B	BUTTERFLY VALVE
	SINGLE STRAINER
	PUMP
	Y-TYPE STRAINER



NOTES:

1. SYSTEM SHOWN IS TYPICAL OF A 6-UNIT PLANT WITH TRANSFORMERS LOCATED ON OUTSIDE DECK. INITIAL INSTALLATION OF 6 TRANSFORMERS IS SHOWN WITH HEADER TO BE EXTENDED LATER FOR 4 ADDITIONAL TRANSFORMERS.
2. SINGLE AND 2 PUMP ARRANGEMENT SHOWN WAS DUE SPACE CONSIDERATIONS IN GALLERY. ALL 3 PUMPS START ACTUATION OF ANY DELUGE VALVE.
3. PUMPING CAPACITY BASED ON SPRAYING ANY 3 ADJOINING TRANSFORMERS SIMULTANEOUSLY.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED

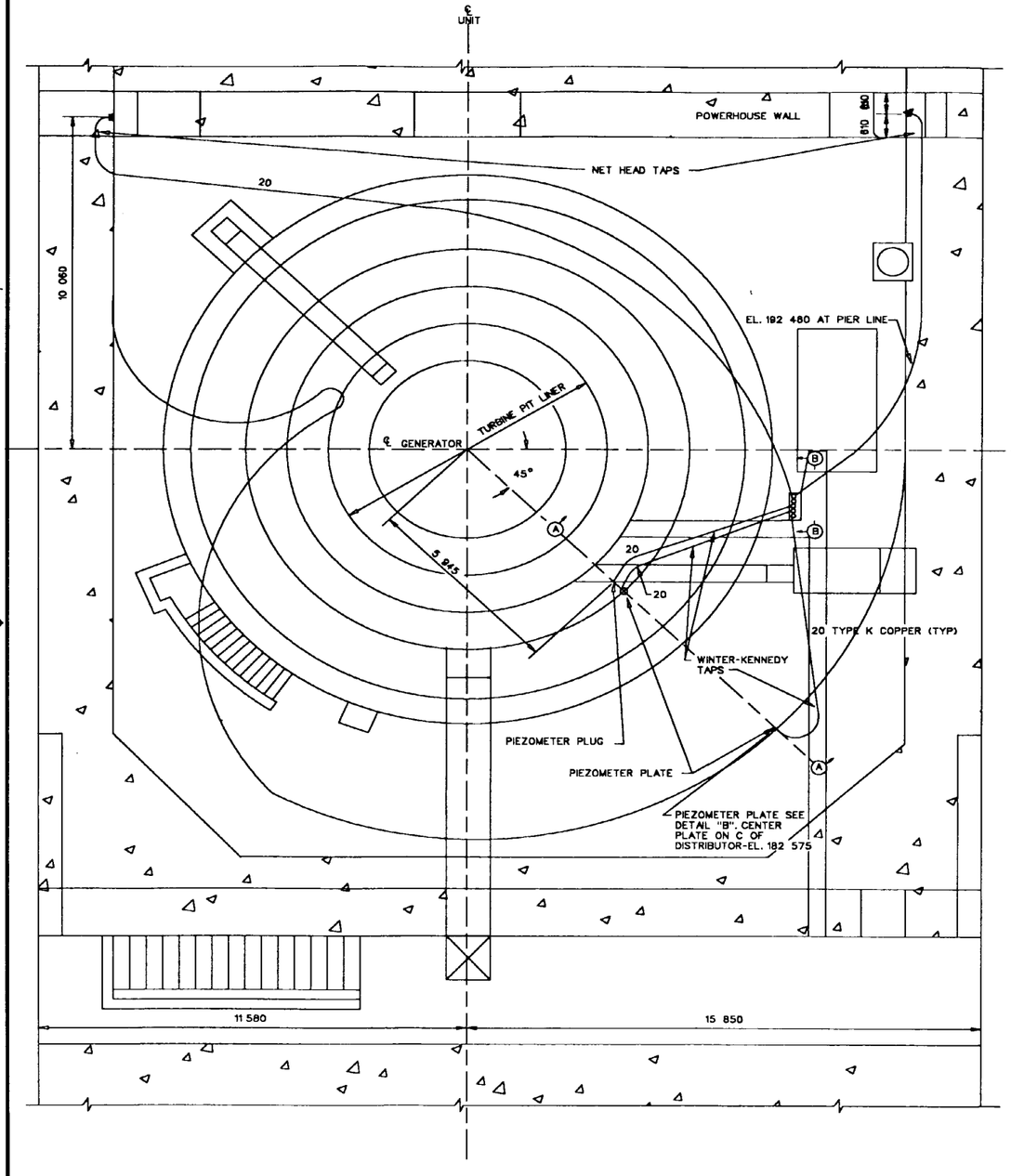
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

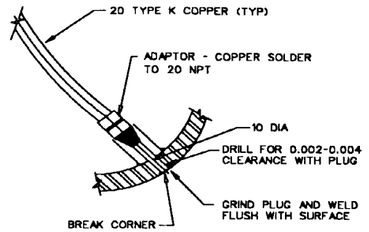
Figure B-17. Transformer deluge system

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

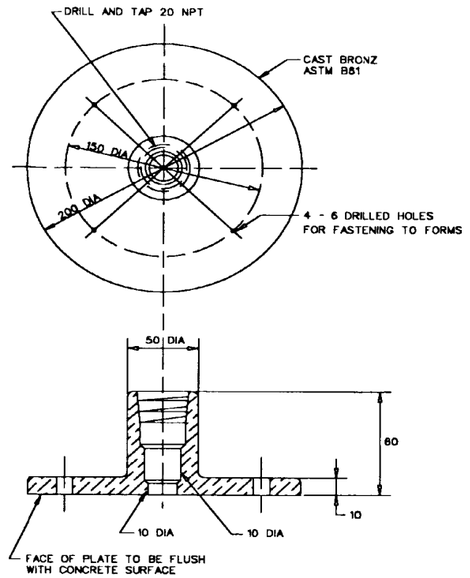
SCALE AS SHOWN | SHEET NO.
DWG NO.



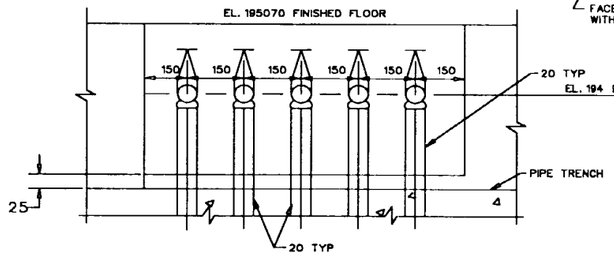
PLAN EL. 195070



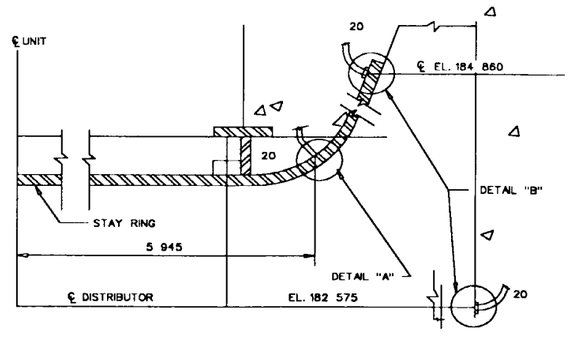
DETAIL "A"



DETAIL "B"



SECTION B-B



SECTION A-A

NOTES:

1. PIEZOMETER PROVISIONS SHOWN ARE TYPICAL OF THOSE IN A LARGE KAPLAN UNIT POWERHOUSE WITH CONCRETE SPIRAL CASES.
2. LINES SLOPE UP FROM TAP 1 PER 50 MINIMUM.
3. LINES SHOULD BE PLUGGED AND IDENTIFIED AS TO SOURCE BEFORE EMBEDMENT.
4. FOR PIEZOMETER PROVISIONS IN FRANCIS UNITS SEE PAGE A-13.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	CHIEF, ENGINEERING DIVISION	CHIEF, CONSTRUCTION DIVISION	CHIEF, OPERATIONS DIVISION

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

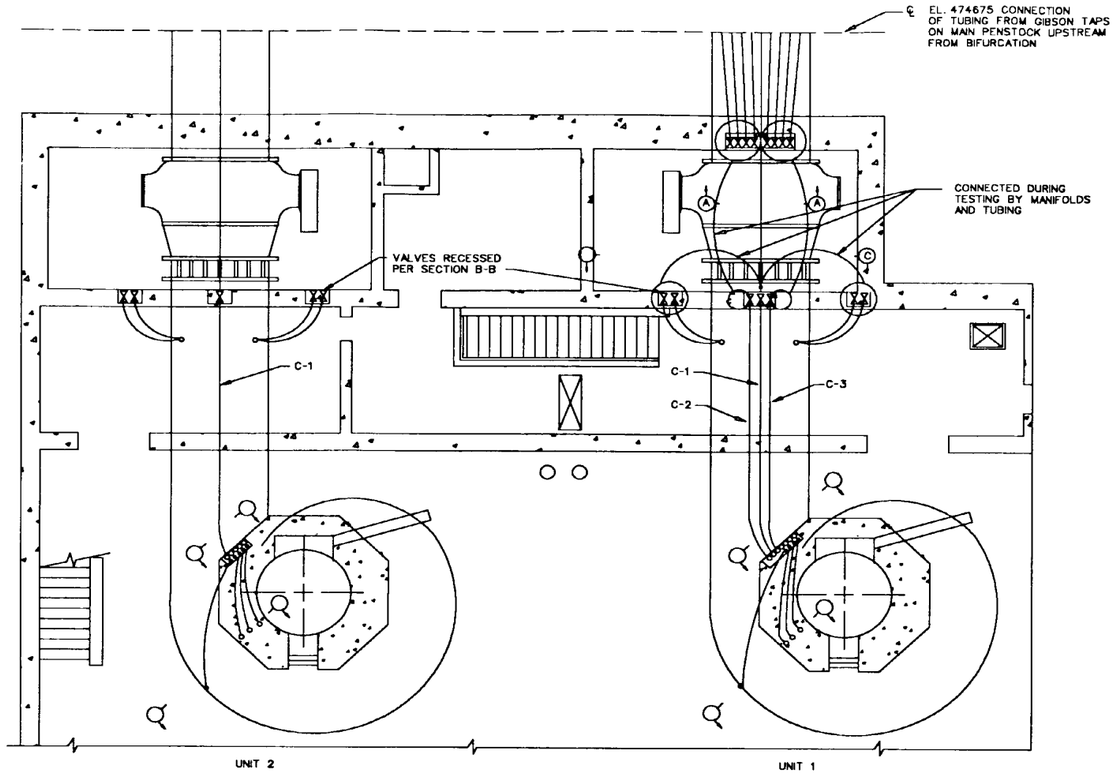
DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-18. Turbine peizometer provisions (Continued)

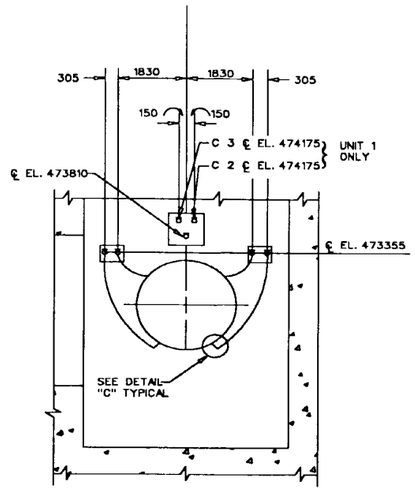
SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.

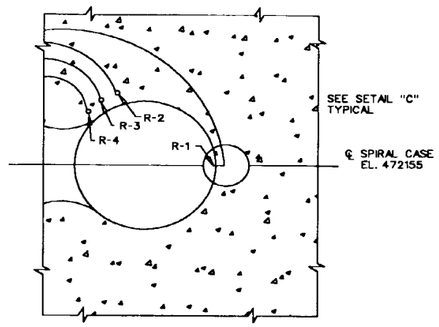
DWG NO.



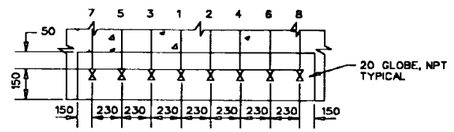
PLAN-ELEV. 1556



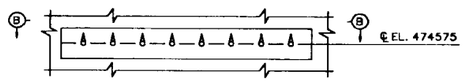
SECTION C-C



SECTION F-F



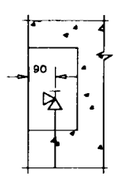
SECTION B-B



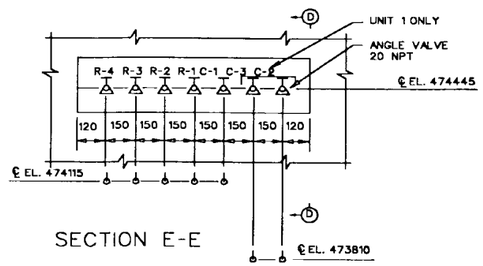
NOTES:

1. PIEZOMETER PROVISIONS SHOWN ARE TYPICAL OF A 2-UNIT FRANCIS PLANT WITH SINGLE PENSTOCK AND BIFURCATION CONNECTIONS TO THE TWO STEEL SPIRAL CASE EXTENSIONS.
2. ALL LINES SHOWN ARE 20 TYPE K COPPER TUBING.
3. SLOPE ALL LINES 1 PER 50 MINIMUM.
4. ON ALL CONNECTIONS TO SPIRAL CASE AND SPIRAL CASE EXTENSION WRAP FIRST 230 OF TUBING AND FITTINGS WITH 1" THICKNESS OF BURLAP TIE PLASTIC FILM OVER BURLAP FOR WATER PROOFING.
5. PLUG LINES AND TAG AS TO SOURCE BEFORE EMBEDMENT.

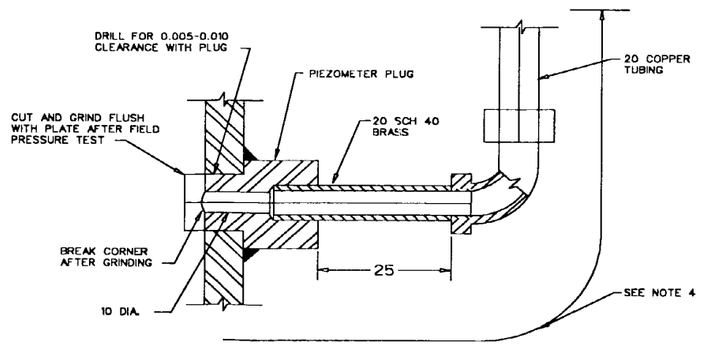
ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE



SECTION D-D



SECTION E-E



DETAIL "C"
PIEZOMETER NIPPLE

REVISION	DATE	DESCRIPTION	CHIEF APPROVED

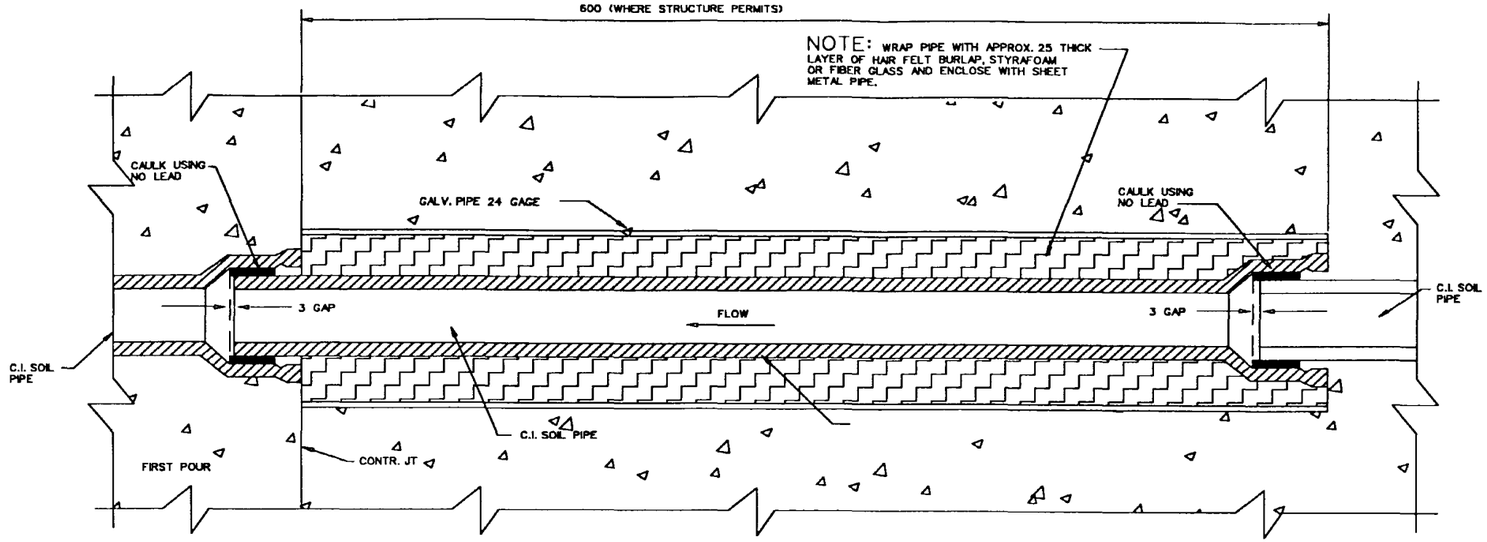
HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:
CHIEF

Figure B-18. (Concluded)

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

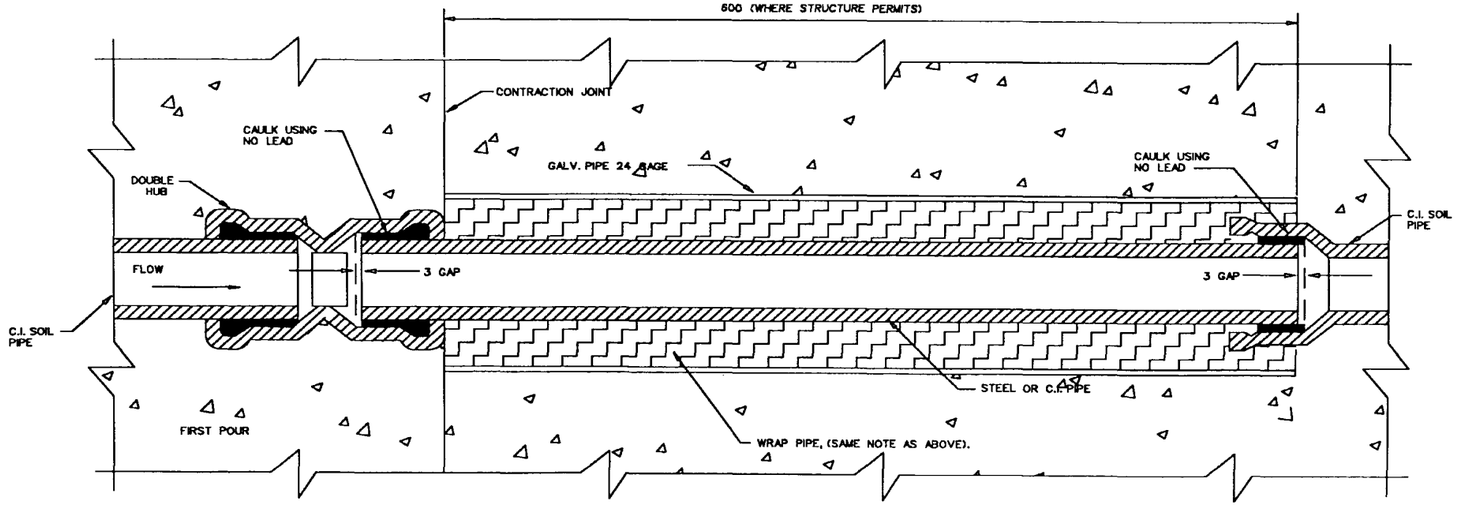
SCALE AS SHOWN | SHEET NO.
DWG NO.



DETAIL "A"
NO SCALE

NOTE: METHOD OF PASSING EMBEDDED SOIL PIPE THROUGH CONTRACTION JOINT WHEN CONCRETE AT DOWNSTREAM END OF PIPE LINE IS PLACED BEFORE THAT AT THE UPSTREAM END.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE



DETAIL "B"
NO SCALE

NOTE: METHOD OF PASSING EMBEDDED SOILPIPE THROUGH CONTRACTION JOINT WHEN CONCRETE AT UPSTREAM END OF PIPE LINE IS PLACED BEFORE THAT AT THE DOWNSTREAM END.

DETAILS OF EMBEDDED DRAINS CROSSING CONTRACTION JOINTS

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

REVISION	DATE	DESCRIPTION	APPROVED

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-19. Embedded drains crossing contraction joints

SUBMITTED:
GLENN R. MELOY, P.E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.

LOSSES IN NEW TYPE "K" COPPER TUBING CARRYING TRANSIL OIL

615 S.S.U.@ 20°F

65.2 S.S.U.@ 100°F

2" 1.959" I.D.

1" 0.955" I.D.

1" 0.527" I.D.

TURBULENT FLOW

LAMINAR FLOW

100° 90° 80° 70° 60° 50° 40° 30° 20°F

G.P.M.

LOSS-FT. OF OIL PER 100 FT. OF TUBING

by NPD, Corps of Engineers, U.S.A.

Figure B-20. Pressure losses of oil in copper tubing (Sheet 1 of 6)

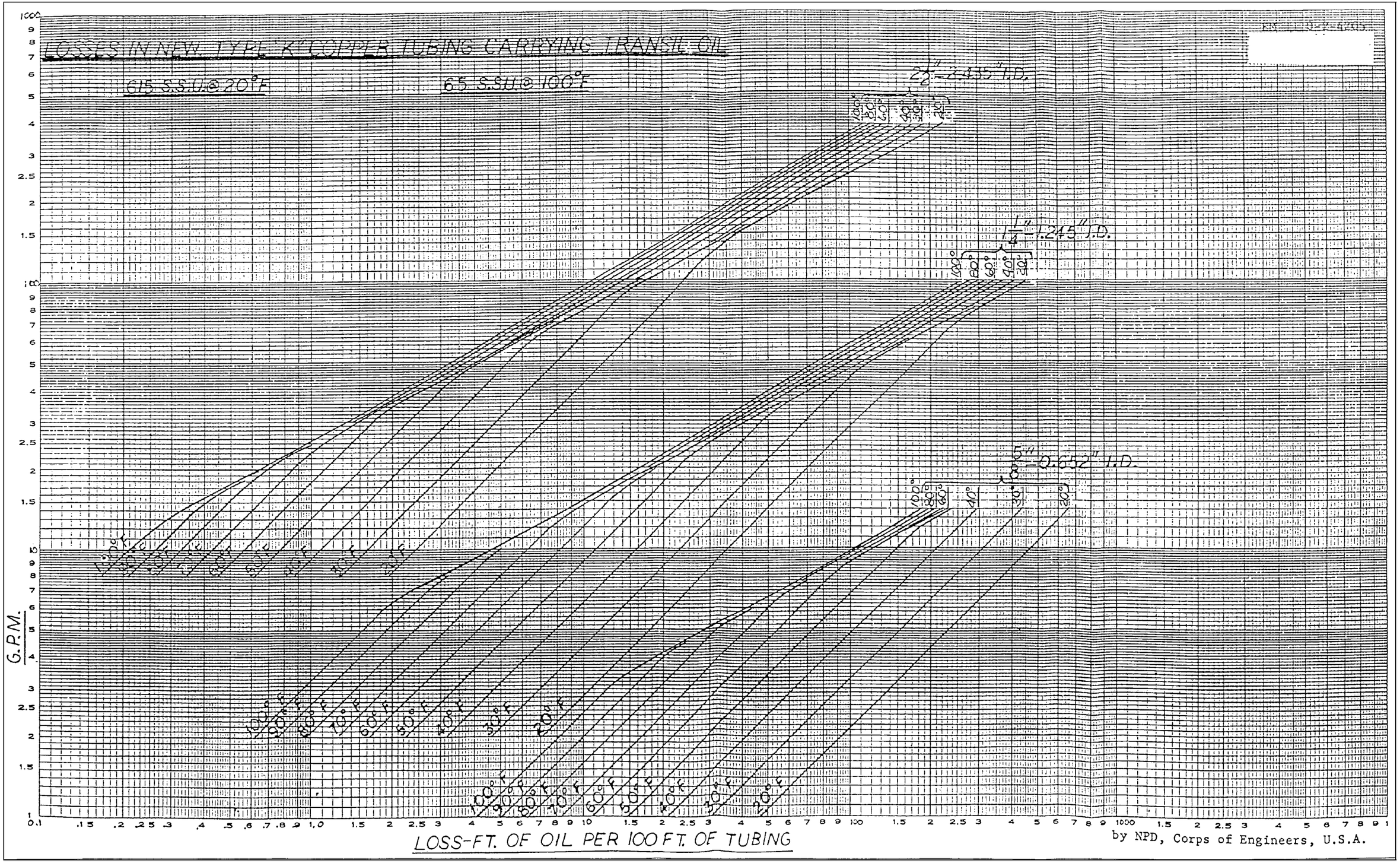


Figure B-20. (Sheet 2 of 6)

LOSSES IN NEW TYPE "K" COPPER TUBING CARRYING TRANSIL OIL

615 S.S.U. @ 20°F

65 S.S.U. @ 100°F

3" 2.907" I.D.

1½" 1.481" I.D.

¾" 0.745" I.D.

G.P.M.

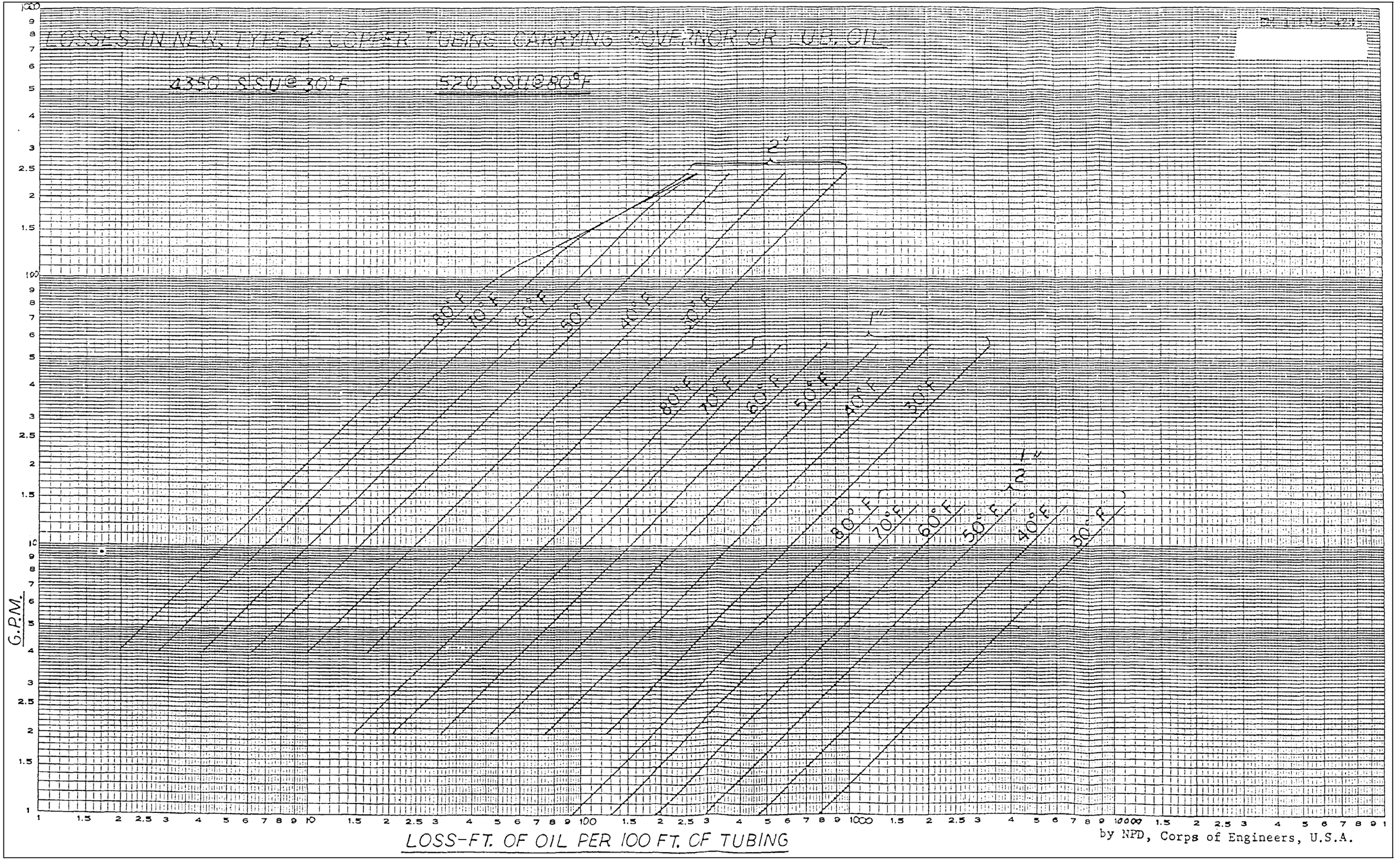
LOSS-FT. OF OIL PER 100 FT. OF TUBING

by NPD, Corps of Engineers, U.S.A.

Figure B-20. (Sheet 3 of 6)

LOSSES IN NEW TYPE K COPPER TUBING CARRYING REFRIGERANT OR LUB. OIL

4350 SSU @ 30°F 520 SSU @ 80°F



by NPD, Corps of Engineers, U.S.A.

Figure B-20. (Sheet 4 of 6)

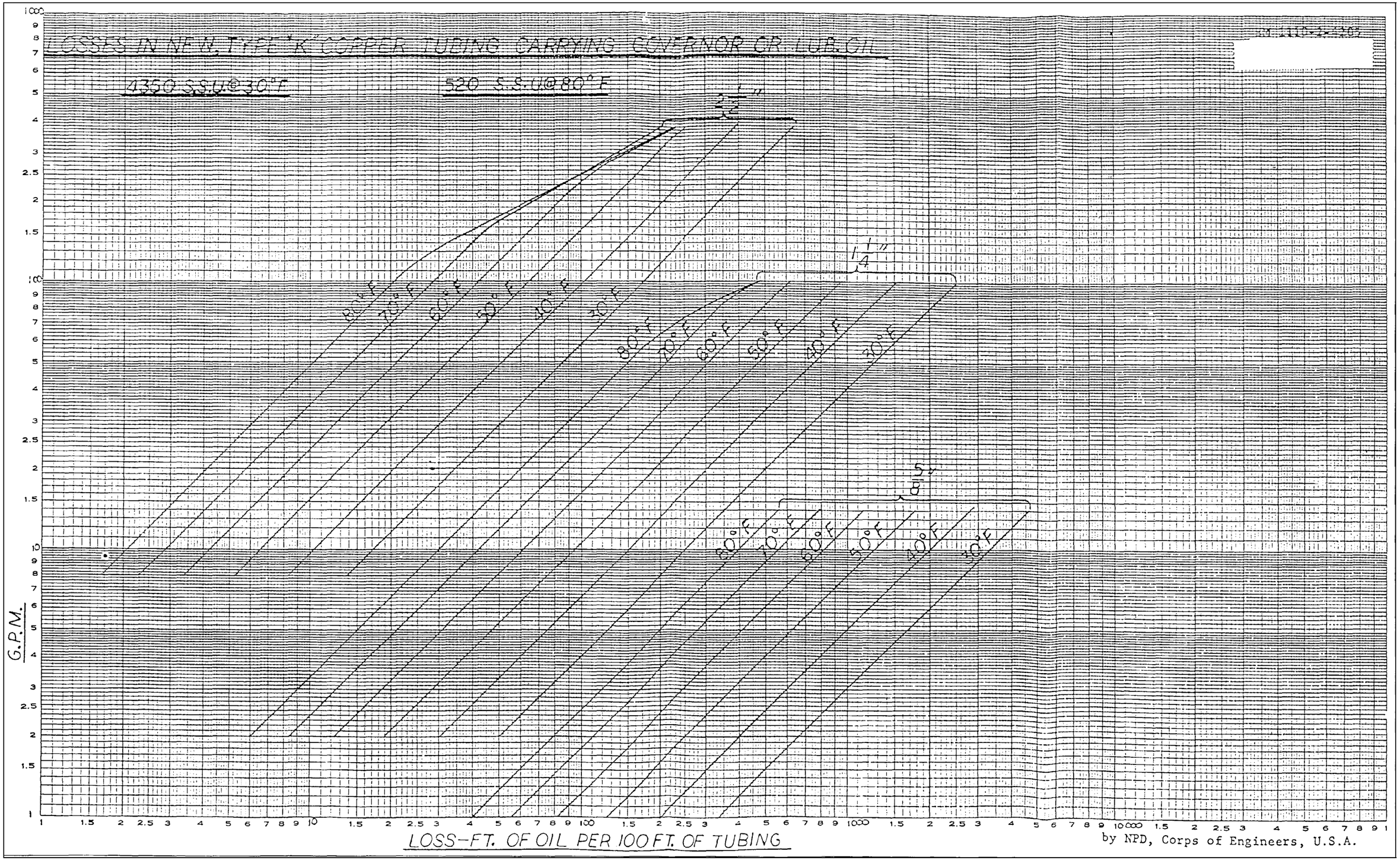


Figure B-20. (Sheet 5 of 6)

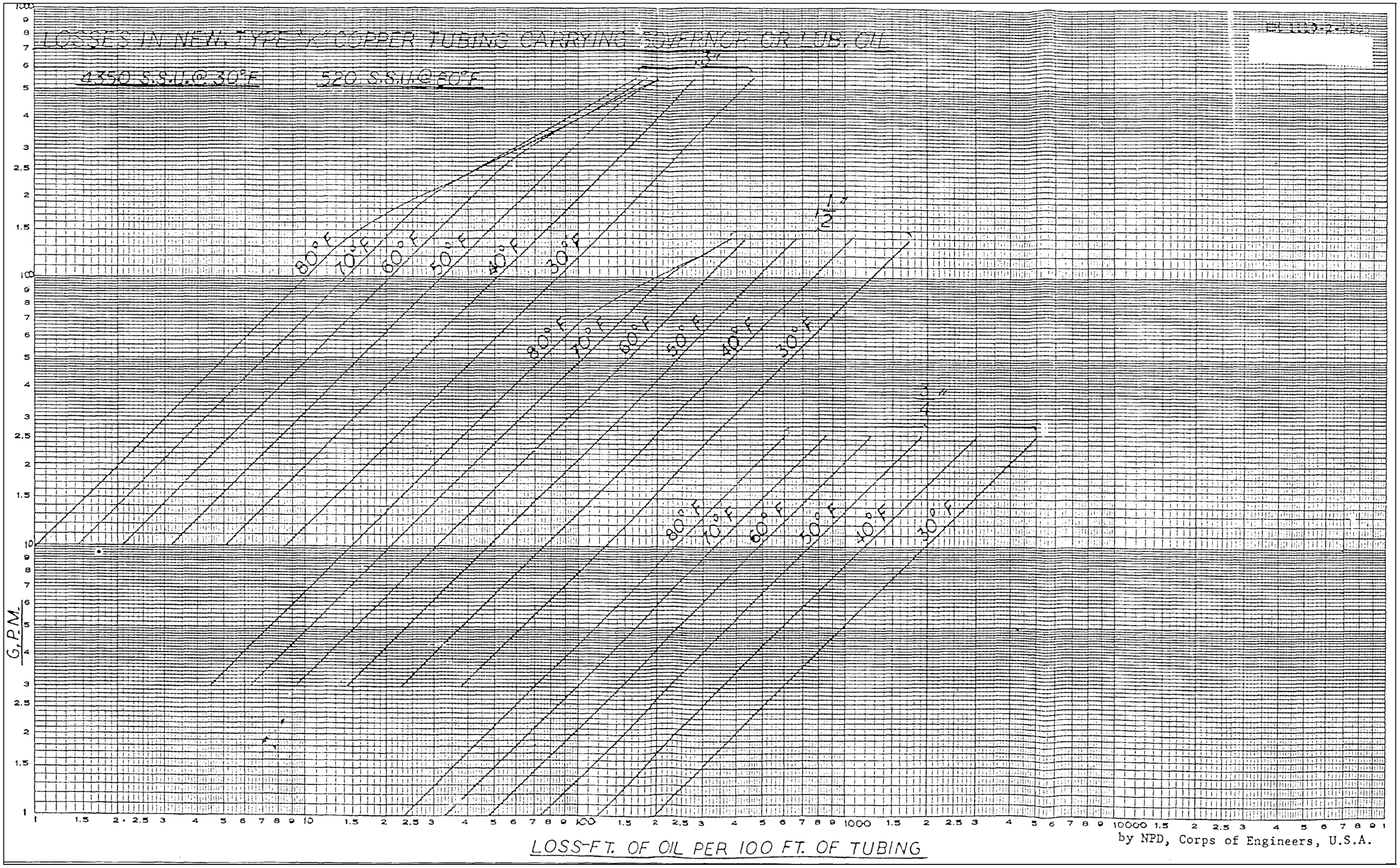
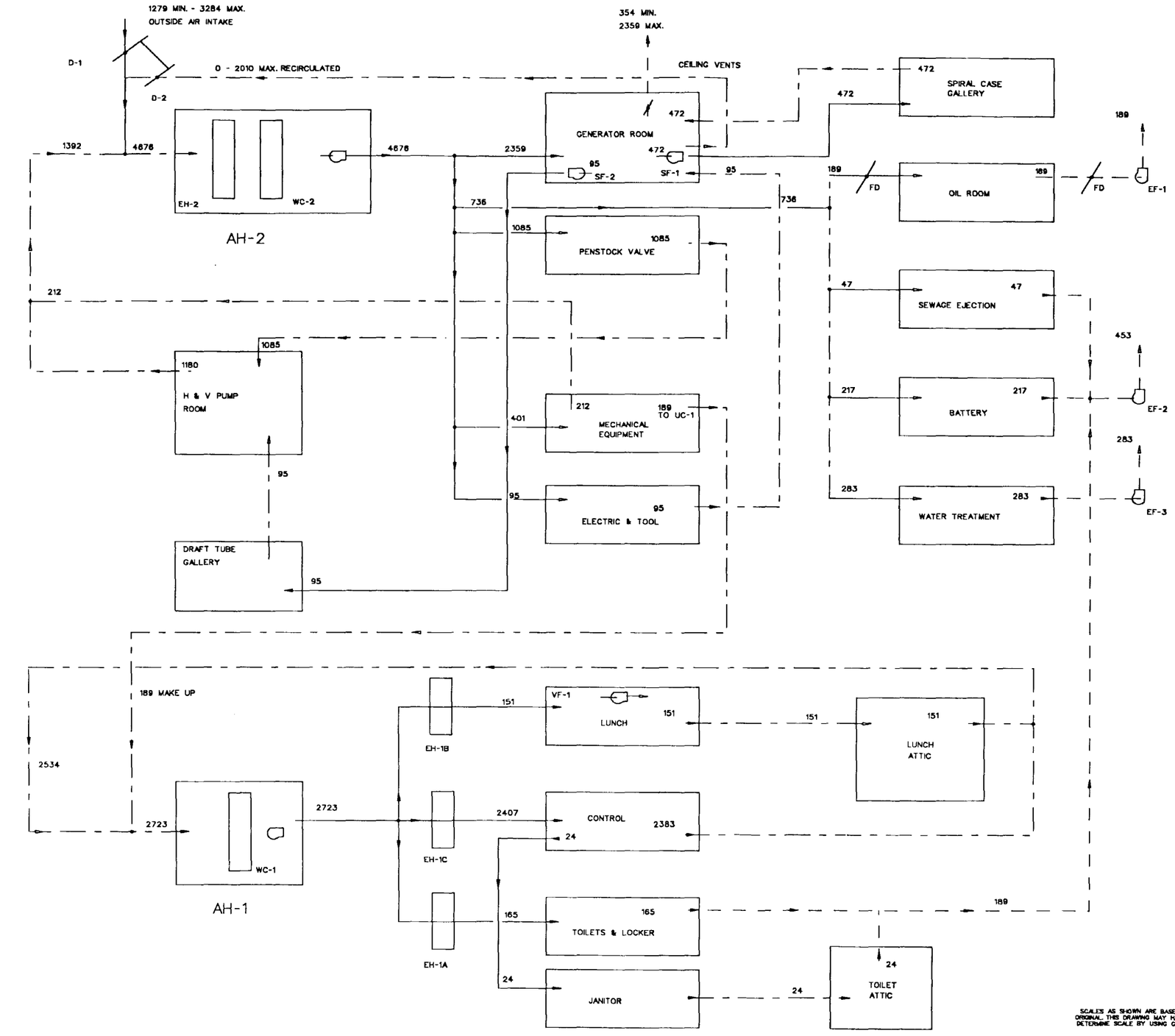


Figure B-20. (Sheet 6 of 6)



UNIT NO. 2 UNIT NO. 1

SYMBOLS	
→	FLOW DIRECTION
——	SUPPLY AIR
- - -	EXHUAST AIR
- — -	RECIRCULATED AIR
	DAMPER
FD	FIRE DAMPER
SF	SUPPLY FAN
EF	EXHUAST FAN
VF	HOOD W/VENTLESS FAN
AH	AIR HANDLING UNIT
EH	ELECTRIC HEATER
WC	WATER COOLING COILING

NOTES:

1. SYSTEM SHOWN IS TYPICAL OF A 2-UNIT POWERHOUSE IN MILD CLIMATE WITH POOL-TAILWATER AVAILABLE AT 7-C FOR SUMMER COOLING AND WINTER HEATING REQUIREMENTS SUPPLIED WITH ELECTRICAL RESISTANCE HEATING.
2. MAINTENANCE SHOP IS OUTSIDE POWERHOUSE.
3. GENERATOR CEILING VENT DAMPERS ARE SET TO MAINTAIN A POSITIVE PRESSURE IN POWERHOUSE.
4. FOR CONTROL DIAGRAM SEE PAGE A-17.

ALL FLOWS ARE IN LITERS PER SECOND UNLESS NOTED OTHERWISE

REVISION	DATE	DESCRIPTION	APPROVED
			CHIEF, BRANCH
			CHIEF, BRANCH
			CHIEF, BRANCH

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:
CHIEF,

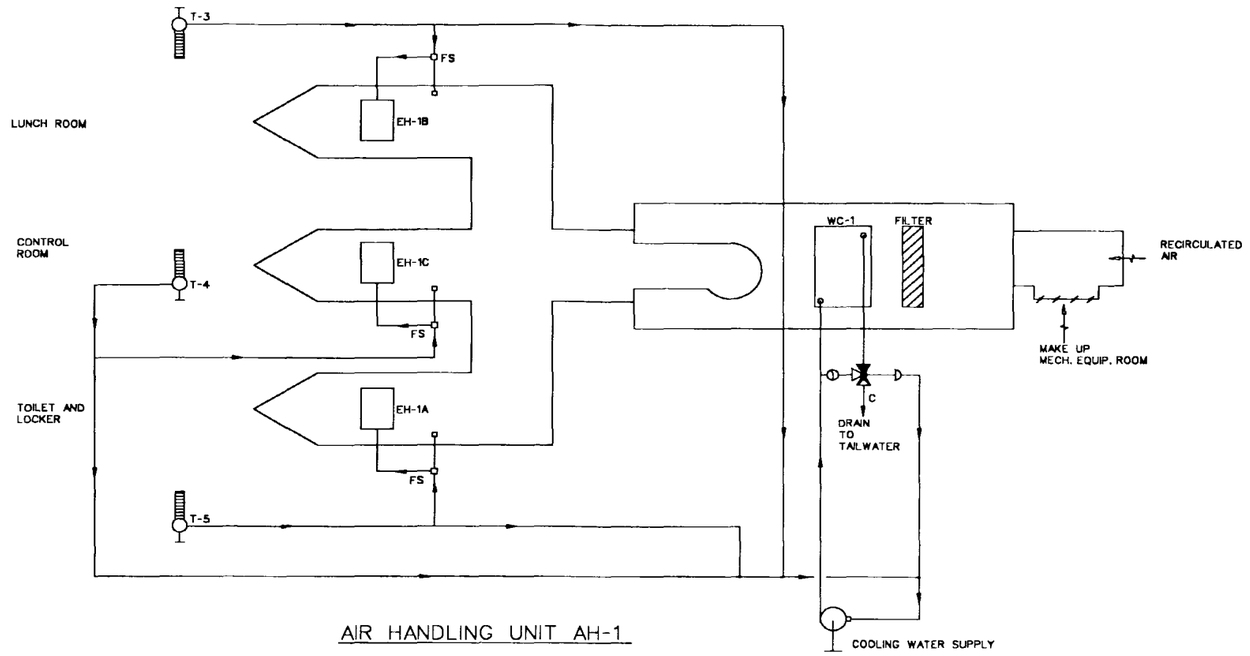
Figure B-21. Ventilation system

SUBMITTED:
GLENN R. MELOY, P. E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
DWG NO.

SCALES AS SHOWN ARE BASED ON AN "F" SIZE ORIGINAL. THIS DRAWING MAY HAVE BEEN REDUCED. DETERMINE SCALE BY USING GRAPHIC SCALE BAR.

MICROSTATION VER 4.0

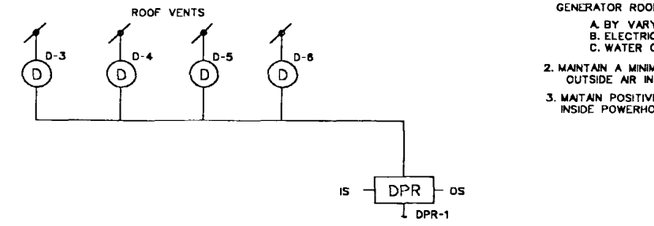


AIR HANDLING UNIT AH-1

SYMBOLS	
	SUPPLY FAN
WC	WATER COIL
EH	ELECTRIC HEATER
	WATER PUMP
SCR	SCR CONTROLLER
DPR	DIFFERENTIAL PRESSURE REGULATOR
T	THERMOSTAT
FS	FLOW SAFETY SWITCH
D	DAMPER & OPERATOR
	MIXING DAMPER/W OPERATOR
	MODULATING 3-WAY VALVE
	BALANCING VALVE
IS	INSIDE
OS	OUTSIDE
N.C.	NORMALLY CLOSED
N.O.	NORMALLY OPENED
	MANUAL DAMPER

BASIC FUNCTION AH-1

1. COOLING CAN BE INITIATED AND CONTROLLED BY WARMEST OF THE THREE AREAS.
2. AREAS REQUIRING HEAT WILL REHEAT THEIR SUPPLY AIR AS NEEDED.

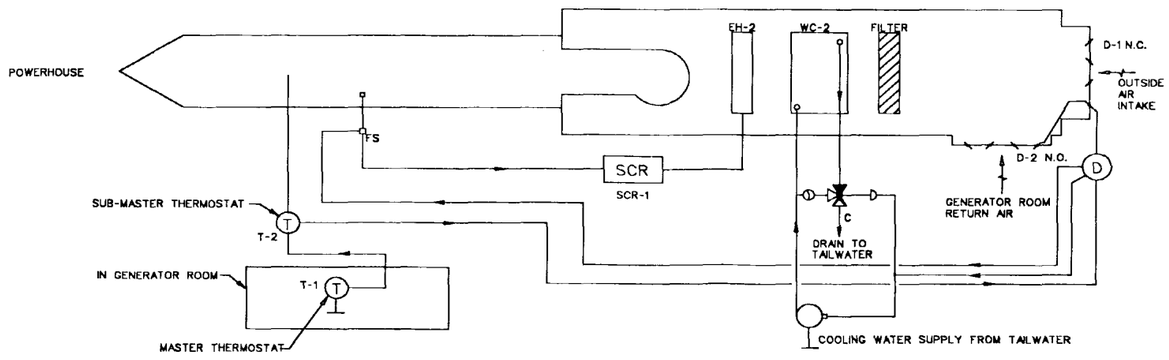


BASIC FUNCTION AH-2

1. CONTROL TEMPERATURE IN GENERATOR ROOM:
   A. BY VARYING MIXING DAMPERS.
   B. ELECTRIC RISISTANCE HEAT.
   C. WATER COOLING COIL.
2. MAINTAIN A MINIMUM OF 1279 LITERS/SEC. OUTSIDE AIR INTAKE.
3. MAITAIN POSITIVE PRESSURE INSIDE POWERHOUSE.

NOTES:

1. CONTROL DIAGRAMS SHOWN ARE THE POWERHOUSE SYSTEM SHOWN ON PAGE A-16.
2. AIR HANDLING UNIT AH-2 HEATERS OR COOLING WATER PUMPS DO NOT OPERATE UNTIL MODULATING DAMPERS REACH LIMIT OF THEIR CONTROL CAPABILITY.



CENTRAL AIR HANDLING UNIT AH-2

REVISION	DATE	DESCRIPTION	CHIEF	ENGINEER
			CHIEF	PLANNING
			CHIEF	ENGINEERING

HYDROELECTRIC DESIGN CENTER
NORTH PACIFIC DIV., PORTLAND, OR

DESIGNED:
DRAWN:
CHECKED:
PREPARED:

Figure B-22. Heating-cooling-ventilation system control

SUBMITTED:
GLENN R. MELOY, P.E.
CHIEF, HYDROELECTRIC DESIGN CENTER

SCALE AS SHOWN | SHEET NO.
348 MS